2014-1798

United States Court of Appeals for the Federal Circuit

IN RE MAGNA ELECTRONICS, INC.,

Appellant.

Appeal from the United States Patent and Trademark Office, Patent Trial and Appeal Board in Reexamination Control No. 90/011,478

BRIEF OF APPELLANT, MAGNA ELECTRONICS, INC.

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NOVEMBER 7, 2014

I. CERTIFICATE OF INTEREST

Counsel for Appellant, certifies the following:

1. The full name of every party represented by me is: MAGNA ELECTRONICS, INC.
2. The name of the real party in interest represented by me is: MAGNA ELECTRONICS, INC.
3. The name of the parent corporation and any publicly held companies that own 10 percent or more of the stock of the party or amicus curiae represented by me is: MAGNA INTERNATIONAL, INC.
4. The names of all law firms and the partners or associates that appeared for the party or now represented by me in the trial court or agency or are expected to appear in this court are:

Gardner, Linn, Burkhart & Flory, LLP: Timothy A. Flory, Terence J. Linn

November 7, 2014

/s/ Terence J. Linn

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IV. STATEMENT OF RELATED CASES

No other appeal in or from the same action in the lower court was previously before this Court or any other appellate court. The patent at issue, U.S. Patent No. 6,222,447 is not the subject of any other appeal pending before this Court.

Appellant is involved in a lawsuit pertaining to U.S. Patent No. 6,222,447:

Magna Electronics Inc. vs. Hyundai Mobis, Co. LTD. et al. (Civil Action No. 2:12-cv-11411, Eastern District of Michigan).

This case on appeal is not related to any other case known to counsel to be pending in this or any other court that will directly affect or be directly affected by this Court's decision in the pending appeal.

U.S. Patent No. 6,222,447 was the subject of an Appeal of the previous Examiner's final rejection of the claims in a first reexamination (Reexamination Control No. 90/007,519) of the '447 patent.

The patent at issue, U.S. Patent No. 6,222,447, is related to U.S. Patent No. 5,949,331, which is the subject of another appeal (Appeal No.: 14-1798) before this court, which is an appeal of the Examiner's final rejection of the claims in Reexamination Control No. 90/011,477.

V. JURISDICTIONAL STATEMENT

Subject matter jurisdiction in the Board of Patent Appeals and Interferences was based upon 35 U.S.C. § 134(b) (pre-AIA). This Court has jurisdiction pursuant to 35 U.S.C. § 141(b) (pre-AIA). This appeal, taken as right from the final decision of the Board of Patent Appeals and Interferences rendered on May 29, 2014, was timely filed pursuant to 35 U.S.C. § 142 on July 24, 2014.

VI. STATEMENT OF THE ISSUES

1. Did the Patent Trial and Appeal Board err in finding that claim 45 of U.S. Patent No. 6,222,447 and claim 107 of U.S. Ex Parte Reexamination Certificate No. 6,222,447 C1 were rendered obvious under 35 USC §103 by the system of JP64-14700 and JP 60-79889 by using the CMOS camera of the Wang article instead of the CCD camera taught by JP '700 and JP '889?

VII. STATEMENT OF THE CASE

This is an appeal of the Final Decision of the Patent Trial and Appeal Board rendered on May 29, 2014 with respect to claims 45 and 107. A1. The Final Decision was from an appeal of the final rejection in the second reexamination of U.S. Patent No. 6,222,447 ("the '447 patent"). A976. The Office Action dated February 24, 2012 rejected claims 4, 32-37, 40-56, 59-65, 67-79, 82-99, 102 and 106-185. A976. Appellant appealed the final rejection of all of the rejected claims (patent claims 38, 39, 57, 58, 80, 81, 100 and 101 were not rejected and thus are not part of this appeal) and the Appellant's Reply Brief (A1504), dated December 10, 2012, to the Examiner's Answer Brief (A1447) of the second reexamination withdrew claims 4, 32-37, 40-44, 46-56, 59-65, 67-79, 82-99, 102, 106 and 108-185 without prejudice, such that only claims 45 and 107 are part of this appeal.

The final rejection and the Board's decision have failed to establish any sustainable question of the patentability of the rejected claims.

VIII. STATEMENT OF THE FACTS

A. The '447 Patent

The claimed invention of the '447 patent comprises a rearview vision system for a vehicle with a CMOS image capture device mounted at the rear of the vehicle. The device has a field of view directed rearwardly of the vehicle. The driver views a display system that shows a rearward image output of the image capture device, including a graphic overlay superimposed on the rearward image when the vehicle is in a reverse gear. The graphic overlay may indicate the vehicle's anticipated travel path and may be disabled when the vehicle is not in reverse. The image capture device comprises a pixelated CMOS imaging array.

B. The '447 Patent Claims at Issue

The following sets forth the limitations of each independent claim and where exemplary support for the limitations are found in the patent specification and drawings. Appellant notes that support for the claim limitations is found throughout the '447 patent, and the portions of the '447 patent that are cited below are cited as examples of such support and the citations are not intended to be construed as citing the only support found in the patents.

Independent claim 45 defines a rearview vision system for a vehicle having a gear actuator, comprising:

an image capture device mounted at the rear of the vehicle and having a field of view directed rearwardly of the vehicle, wherein said image capture device comprises a pixelated imaging array and wherein said pixelated array comprises a CMOS imaging array (A26, 3:51-67; A28, 7:1-7);

a display system viewable by a driver of the vehicle which displays a rearward image output of said image capture device (A26, 4:1-15);

a graphic overlayer superimposed on said rearward image when the gear actuator of the vehicle selects a reverse gear (A29, 10:32-41); and

wherein said graphic overlayer is disabled when the gear actuator of the vehicle is not in reverse gear (A29, 10:53-55).

Independent claim 107 defines a rearview vision system for a vehicle having a gear actuator, comprising:

an image capture device mounted at the rear of the vehicle and having a field of view directed rearwardly of the vehicle (A26, 3:51-67; A29, 10:39-41);

wherein said image capture device comprises a pixelated imaging array, and wherein said pixelated array comprises a CMOS imaging array (A28, 7:1-7);

a display system viewable by an operator of the vehicle which displays a rearward image output of said image capture device (A26, 4:1-15);

a graphic overlay superimposed on said rearward image when the operator of the equipped vehicle positions a gear actuator of the vehicle in a reverse gear (A29, 10:32-41); and

wherein said graphic overlay is disabled when the gear actuator of the vehicle is not positioned in a reverse gear (A29, 10:53-55).

C. References Cited in the Office Action

1. Japanese Patent Application No. 64-14700

JP '700 discloses a vehicular predicted path display device that shows a predicted path of a vehicle when the vehicle is traveling in reverse. JP '700 teaches the use of frames aligned at intervals along the predicted locus to present a perspective feeling. The predicted path display device of JP '700 displays the predicted locus when the vehicle is traveling in reverse and in response to a steering sensor that detects a turning angle of the steering wheel of the vehicle at the time of reverse travel. JP '700 thus discloses a predicted path display device that displays a predicted path of the vehicle during reverse travel and thus in response to movement of the vehicle in the reverse direction at the time of the reverse travel. A288.

2. Japanese Patent Application No. JP 60-79889

JP '889 discloses an in-vehicle television receiver that is combined with a rear view confirming television camera of the vehicle. The television receiver presents a positional relationship to a vehicle in a photographed image of the rear view confirming television camera in a screen. JP '889 teaches away from use of a CMOS

camera to use of a television camera, and JP '889 is wholly silent on what field of view exists for its rear view confirming television camera or what level of image distortion is involved. A349.

3. Wang et al., "CMOS Video Cameras"

Wang discloses a single chip CMOS Video Camera and discusses the architecture and functions of such a CMOS Video Camera. There is no disclosure or suggestion of implementing such a CMOS Video Camera on a vehicle, and particularly in the form and for the function as claimed herein. Rather, Wang provides a generic disclosure of a CMOS Video Camera, and is cumulative to the other references cited during prosecution of the application that issued as the '447 patent, and is cumulative to the disclosure in the specification of the '447 (A28, 7:1-8) that the image capturing device may be a CMOS imaging array of the type manufactured by VLSI Vision Ltd. of Edinburgh, Scotland, or a charge-coupled devices (CCD).

IX. SUMMARY OF THE ARGUMENT

This is an appeal of the Board decision from the Patent Trial and Appeal Board affirming the final rejection in the second reexamination of U.S. Patent No. 6,222,447 ("the '447 patent"). A17. The Final Office Action dated February 24, 2012 rejected claims 4, 32-102 and 106-185, (A976) and the Board (after the case was limited to only claims 45 and 107) affirmed the rejection (A1), and Appellant appeals the Board's decision affirming the final rejection of claims 45 and 107. The Board decision and the final rejection failed to establish any sustainable question of the patentability of the rejected claims.

As clearly indicated below, this appeal should succeed at least because Wang does not disclose or suggest use of a CMOS camera in a vehicle vision system as claimed (collectively and combined with the other claimed aspects). Wang merely discloses an early development of a CMOS camera. *See* A297. The Board merely asserts that it would have been obvious to combine the teachings of Wang with the teachings of other vision systems, because an automobile is a vision system. A5. Thus, independent claims 45 and 107 should be allowed. The Board expands the field beyond automotive vision systems to all vision systems, ignoring the special characteristics noted in the evidence. A11. This allows the Board to rely on the Examiner's incorrect belief that "Wang solved the purported long-felt need." A1135. Plainly, this is preposterous. Wang merely discloses an early development

of a CMOS camera, and nothing more. Such a disclosure, by itself, in no way solved the long-felt need in the art to provide the economical and effective camera-based backup system of the presently claimed invention. Wang can only be alleged to "solve the purported long-felt need" through hindsight reconstruction and viewing Wang in conjunction with the disclosure and claims of the '447 patent, which is improper.

The Board relied on the Examiner's conclusion, despite the Examiner admitting to not understanding the technical details of the response. The Examiner asserted that the prior arguments were confusing and required Appellant to determine what the applied art shows. A1090. Such a requirement is not the responsibility of Appellant. Appellant has rebutted the rejection of obviousness by showing that, regardless of what may actually be disclosed in the applied art, the applied art clearly does not disclose or suggest or render obvious the presently claimed invention. That is sufficient to overcome the rejections. *See* MPEP § 2145 (stating that the burden of persuasion shifts to the applicant *if* a *prima facie* case of obviousness is alleged).

The Board did not accord sufficient or proper weight to Dr. Lynam's Declaration and the factual evidence submitted therewith. *See* A6-7. Dr. Lynam's Declaration includes factual evidence in support of the non-obviousness of the presently claimed invention. A1398. The Board repeats the Examiner's incorrect

allegations that the declaration is merely arguments submitted by an interested party and fails to appropriately consider the objective evidence present in the Lynam Declaration and in its exhibits. A6-7; A1127-29. When the Applicant submits evidence to rebut an alleged *prima facie* case of obviousness, the Examiner must consider the submitted evidence. *In re Rinehart*, 531 F.2d 1048, 1052 (CCPA 1976); MPEP § 2145 (citing *In re Grose*, 592 F.2d 1161, 1168 (CCPA 1979).

The Board and Examiner inappropriately weighed the secondary considerations. For example, the Examiner noted that there is no copying. A1134. How does the Examiner know this? Factual evidence, in the form of a declaration, has been submitted to show copying, but the Board stated that Dr. Lynam's declaration should be given little to no weight because Dr. Lynam is interested in the outcome of the reexamination. A6-7; A1128-29. The attack on Dr. Lynam's standing is improper. *See* MPEP § 2145 (citing *In re Alton*, 76 F.3d 1168, 1174-75 (stating that a declaration containing factual evidence should be given weight)). Regardless of whether or not Dr. Lynam has a vested interest in this case, the facts are the facts and they are clearly set forth in the text and exhibits of Dr. Lynam's Declaration, much of which is from published reports and general literature that is distinct and independent from Dr. Lynam. The Examiner unfairly classified the

Lynam Exhibits as "unverified exhibits." A1117. The exhibits are part of a sworn declaration. Thus, they clearly are verified.

The Examiner stated and the Board affirmed that the evidence of commercially available rear-vision camera systems does not show that the systems were commercially successful. A9; A1135. This is contradictory to the evidence submitted that shows that the systems in production today practice the claimed invention of the '447 patent and not the prior art. It is the production and sales of the claimed invention across several vehicle manufacturers and vehicle product lines that evidences the substantial commercial success of the claimed invention. *See* MPEP § 716.03(a)(I) (citing *In re Tiffin*, 448 F.2d 791 (CCPA 1971) that objective evidence of commercial success commensurate with the scope with the claims shows nonobviousness). Automakers are notoriously cost conscious and have the choice for a lower price of not using graphic overlays or guidelines. Plainly, that so many vehicles across so many automakers are at dealerships today with the rear vision system and graphic overlay as claimed is clear and convincing evidence of commercial success with a straight nexus with the claim elements.

At least for these reasons, and as discussed in detail below, the rejections of the claims should be reversed.

X. ARGUMENT

A. Standard of Review

Obviousness is ultimately a legal conclusion, and this Court reviews the Patent and Trial Appeal Board's legal conclusions de novo. Underlying factual determinations are reviewed for substantial evidence. *Tempo Lighting, Inc. v. Tivoli, L.L.C.*, 742 F.3d 973, 976-77 (Fed. Cir. 2014) (holding that obviousness is a question of law reviewed de novo).

B. No *Prima Facie* Case of Obviousness Established

Appellant submits that the claim elements are not disclosed or suggested in the applied art. As discussed in detail below, Appellant submits that the Decision has not established a *prima facie* case of obviousness at least because (a) there is no suggestion or motivation either in the references themselves or in the knowledge generally available to one of ordinary skill in the art to modify the references or combine the reference teachings to arrive at the claimed invention; (b) at the time of the invention, there would not have been a reasonable expectation of success in combining the prior art references; and (c) the prior art, taken as a whole, teaches away from the claimed invention.

C. The rejection of Independent Claim 45 Under 35 U.S.C. §103(a) Over Japanese Laid Open Patent Application No. JP 64-14700, in view of Japanese Laid Open Patent Application No. 60-79889 is Improper

With respect to the rejection of Independent Claim 45 under 35 U.S.C. §103(a) over Japanese Laid Open Patent Application No. JP 64-14700 (hereinafter "JP '700"), in view of Japanese Laid Open Patent Application No. 60-79889 (hereinafter "JP '889"), claim 45 includes a pixelated imaging array comprising a CMOS imaging array. The other claim limitations are similar to those addressed above, such that Appellant submits that the applied art does not disclose or suggest or render obvious the claimed invention of independent claim 45 for at least the reasons set forth below.

1. The Applied Art Does Not Disclose or Suggest a CMOS Imaging Array as Claimed

The rejection of claim 45 relies on the concept that it would have been obvious to one of ordinary skill in the art to combine the teachings of JP '700 and JP '889 and that such a combination establishes a *prima facie* case for obviousness. Appellant respectfully traverses. Wang merely discloses the existence of a CMOS camera, but makes no suggestion of use of such a device in a vehicle application. A297. Nor do any of the cited references provide any guidance as to why one of ordinary skill in the art would have been led to combine the teachings of JP '700 and/or JP '889. Clearly, in the early 1990s, the prior art as a whole taught towards use of CCD

cameras rather than CMOS imaging devices as the reliable cameras for vehicle applications.

The Board alleges that combining the teachings of Wang with the teachings of JP '700 and/or JP '889 would have been obvious. A5-6. However, such a combination is only made using hindsight reconstruction in view of the disclosure and claims of the '447 patent, which is impermissible. *See* MPEP § 2145 X.A (*citing In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971) that Examiners should only consider knowledge that was within the level of ordinary skill in the art at the time the claimed invention was made and not knowledge gleaned only from applicant's disclosure).

Moreover, the Board failed to provide necessary support for combining the teachings of Wang, JP '700, and JP '889. In making the rejection of independent claim 45, the Board agreed with the Examiner (A5-7), who merely stated:

> **Wang Publication** discloses:
> A single chip CMOS video camera is presented, along with a design technique and characterization results. The chip comprises a 312 c 287 pixel photodiode array toegether with all the necessary sensing, addressing and amplifying circuitry, as well as 1,000 gate logic processor, which implements synchronization timing to deliver a fully-formatted composite video signal. A297.
>
> Camera and vision systems addressed by today's CCD technology appear cumbersome, power hungry and expensive. The experimental work reported here demonstrates that high-quality image sensors can be implemented entirely in commodity ASIC CMOS technology, operating form single 5v supplies. A297.

A1006. The Examiner merely quotes portions of Wang, which plainly do not reference any application of a CMOS video camera to a vehicle vision system, particularly as claimed in independent claim 45. Nothing more is provided in making the rejection of independent claim 45.

The Decision appears to repeat the Examiner's allegation that, at the time of the invention, replacing the known CCD cameras or television cameras of JP '700 or JP '889 with a CMOS imaging device from Wang would have been obvious to one of ordinary skill in the art to arrive at the presently claimed invention. Appellant respectfully traverses.

Wang discloses a CMOS Video Camera and discusses the architecture and functions of the CMOS Video Camera. Appellant submits that there is no disclosure or suggestion of implementing such a CMOS Video Camera on a vehicle, and particularly in the form and for the function as claimed herein, and clearly there is no disclosure or suggestion of implementing a pixelated imaging device having an array of photosensing elements, such a CMOS Video Camera, as part of a vehicular rearview vision system, particularly as claimed herein.

Rather, Wang provides a generic disclosure of a CMOS Video Camera, and is cumulative to the other references cited during prosecution of the application that issued as the '447 patent, and is cumulative of the statements in the specification of

the '447 patent that the image capturing devices 14, 16 may be a CMOS imaging array of the type manufactured by VLSI.

The mere existence of CMOS cameras as an emerging technology in the early 1990s does not render obvious their use for the purposes and in the manner disclosed in the '447 patent and in its priority filings. This is evidenced by CMOS camera systems for vehicular back-up systems only relatively recently emerging into commercial usage on production vehicles. A1407¶31. The Wang article makes no disclosure or suggestion to use such a CMOS imager for an automotive application of any sort, and is cumulative over the prior art and disclosure that was examined during prosecution of the claims of the issued '447 patent. A297.

It is both remarkable and telling that no automotive CMOS prior art came before the ‘447 patent (and clearly the third party requester was unable to find any such art), but a flood followed, albeit beginning a considerable time after the '447 patent, given the prevailing and lingering skepticism and doubt by automotive experts as to the utility and usefulness of CMOS imagers for automotive use in general and for automotive backup cameras, such as disclosed and claimed in the '447 patent, in particular.

Moreover, the Board affirmed the Examiner's contention that Wang solved a purported long-felt need. A11. However, Wang merely discloses an early development of a CMOS camera, and nothing more. A297. Such a disclosure, by

itself, in no way solved the long-felt need in the art to provide the economical and effective vehicular camera-based backup ***system*** of the presently claimed invention, which includes much more than just a CMOS imaging array. The subject claims of the present reexamination are replete with multiple claim elements, which are neither disclosed nor suggested in Wang. To suggest that Wang is the solution to the long-felt need is simply preposterous. Wang can only be alleged to "solve the purported long-felt need" through the Examiner's hindsight reconstruction and viewing Wang in conjunction with the disclosure and claims of the '447 patent, which is improper.

Further, there is an abundance of evidence of non-obviousness of the claimed invention over the prior art, as discussed in detail below. Such secondary considerations include, for example: (a) the commercial success of the invention of the '447 patent, such as in the commercially available vehicles (*see* A1348-51, A1355-57, A1373-83) (b) the invention of the '447 patent has satisfied the long-felt need in the art that, for decades, the automotive industry sought an effective, economic way to avoid backing over children or objects from a standing start, (c) the success of the invention of the '447 patent where others have failed (the complicated systems of JP '700 and JP '889 are not in commercially available vehicles today), (d) the success of the invention of the '447 patent in the face of skeptics and experts because, in spite of JP '889 having been filed in 1983 and JP '700 having been filed in 1987, two decades later reverse-aid systems of the types

described in the '447 patent are only relatively recently proliferating, (e) the prior art as a whole teaches away from the invention of the '447 patent, (f) the recognition of the problem by the '447 patent by recognizing that there is a problem to be solved before the time that rearward travel commences, (g) the licensing of the claimed invention of the '447 patent to others, and (h) the copying of the claimed invention of the '447 patent by others.

During prosecution of the application that issued as the '447 patent, the examining Examiner recognized that prior generic disclosures of CMOS imaging devices do not disclose or suggest the present invention, particularly as claimed in the '447 patent. Moreover, Appellant respectfully submits that the third party requestor of the first reexamination of the '447 patent recognized that the claims drawn to the CMOS imaging array are patentable, and thus did not request reexamination of patent claims 14 and 45 of the '447 patent.

Moreover, secondary considerations, including evidence of commercial success of the claimed invention, long felt, but unsolved need in the art, teaching away from the claimed invention by the prior art, recognition of a problem to be solved by the claimed invention, licensing of the claimed invention and copying of the claimed invention by others, further augment the novelty and non-obviousness of the claimed invention. A1358-59; A1385. Accordingly, Appellant respectfully

submits that the combination of JP '700 and JP '889 and Wang does not disclose or suggest or render obvious the claimed invention as claimed herein.

Furthermore, the Wang article was co-authored by Dr. Peter Denyer of the University of Edinburgh, Scotland. A1407-08¶31. The '447 patent discloses innovative automotive usage of CMOS imaging arrays of the type manufactured by VLSI (*see* A28, 7:1-8). VLSI was a campus spin-off company from Dr. Denyer's work at the University of Edinburgh. Appellant became an investor in VLSI in the early 1990s and did so because use of CMOS cameras were, in the early 1990s, neither used nor were they available for use in the automotive arena to automotive standards, requirements and expectations. An inventor on the '447 patent, Kenneth Schofield, first recognized in the early 1990s that such types of CMOS imagers may have particular potential for use in automotive vision systems and he was a pioneer in the use of CMOS cameras in vehicles in general, and for camera-based backup aids in particular. A1407-08¶31.

Upon conceiving that CMOS imagers would have innovative deployment in the automotive arena, Kenneth Schofield contacted Dr. Denyer at the University of Edinburgh in Scotland, and when he did it was because innovation was at work by Kenneth Schofield. Kenneth Schofield interacted with Dr. Denyer on what was, as of the early 1990s, a still-emerging image sensor technology. Donnelly Corporation entered into a research and development program with Dr. Denyer/VLSI, and

Donnelly Corporation took an equity stake in VLSI, which further corroborates and evidences that Schofield pioneered in the early 1990s the development and deployment of automotive CMOS imagers for vehicular vision systems. A1411-12¶37.

Appellant respectfully submits that the mere existence of Wang's academic paper in the early 1990s on a particular development of a CMOS camera does not render obvious its use for the purposes, and in the manner, disclosed in the '447 patent and claimed herein. This is evidenced by the fact that even the third party requester that initiated this reexamination did not request reexamination of the "CMOS claims" of the '447 patent when making its first reexamination request dated April 22, 2005 in the 90/007,519 reexamination, and this is further evidenced by CMOS camera systems for vehicular backup systems only relatively recently emerging into widespread commercial usage on production vehicles. A1407-08, A1409-10¶¶31, 35.

It is also telling that in this its second reexamination request, and in spite of digging deep into the depths of prior art, the third party requester of this second reexamination again has failed to come up with a single prior art reference that discloses or suggests use of a CMOS imager for an automotive application of any sort. A1409¶33. Wang makes no disclosure or suggestion to use such a CMOS imager for an automotive application of any sort, and is cumulative over the prior

art that was examined during prosecution of the issued '447 patent claims. A1408 fn. 2 (*stating* "Indeed US '447 at column 7, lines 1-9, calls out a preferred CMOS imaging array to be of type manufactured by Dr. Denyer's company, VLSI"). Moreover, the other cited art, including JP '889 and JP '700, clearly disclose use of television cameras or CCD cameras. A288, A349.

Appellant respectfully submits that, in the early 1990s, one of ordinary skill in the art, armed with the disclosures of JP '700 and/or JP '889 and Wang would not have been motivated to use a CMOS camera for the automotive systems of JP '700 and/or JP '889. This is at least because one of ordinary skill in the art in the early 1990s would have viewed CMOS imager technology to be insensitive in low light conditions (and thus not particularly suitable for use as a rear backup camera at night), to have inferior image quality and to be difficult and costly to make. These concerns would motivate such artisans not to think of or use CMOS imagers, and would motivate them to continue to use CCD imagers for automotive applications (as indeed they did). At the time of the present invention and until only relatively recently, automotive imagers mostly were CCDs, such as clearly disclosed in the art applied in the Decision. At that time period, CMOS cameras were not seen to be the tool of choice, but with the foresight and innovative development done by Schofield, CMOS cameras have now emerged that are suitable for use, and are now widely used, on automobiles. A1408-09¶32.

In addition, Appellant submits that the prior art must be considered as a whole, and when this is done, it is clear that the prior art of record herein collectively teaches away from use of a CMOS imager in a rearward vision system of a vehicle, in accordance with the claimed invention. *See In re Dow Chemical Co.*, 837 F.2d 469, 473 (Fed. Cir. 1988) (stating "In determining whether such a suggestion can fairly be gleaned from the prior art, the full field of the invention must be considered; for the person of ordinary skill is charged with knowledge of the entire body of technological literature, including that which might lead away from the claimed invention") (emphasis added); *See also In re Hedges*, 783 F.2d 1038, 1041 (Fed. Cir. 1986) (stating "We agree with *Hedges* that the prior art as a whole must be considered. The teachings are to be viewed as they would have been viewed by one of ordinary skill.") (emphasis added).

This is at least because in the early 1990s, CMOS imaging technology was as yet in its infancy, with known problems and drawbacks (such as insensitivity to low light, inferior image quality and challenging and costly fabrication).

Design and performance requirements in automotive applications are challenging, and the artisans would have not been motivated to move in the direction of the '447 patent but to the contrary, would be motivated to shy away from the present invention and follow the then conventional path via use of CCD automotive cameras (indeed, as the market data discussed below attests, this is what happened

in the real-world, with the likes of Japanese automotive backup camera suppliers continuing to cleave to CCD imagers long after the early 1990s). Thus, Appellant respectfully submits that one of ordinary skill in the art, armed with JP '889 and JP '700, would be led towards a CCD camera and away from a CMOS imager of the type claimed herein. A1431-32¶75.

Nor would one of ordinary skill in the art in the early 1990s reasonably expect success in use of a CMOS imager in an automotive rearward vision system of the types claimed herein. Back in the early 1990s, that such CMOS imagers were still relatively in their infancy and were known to exhibit the likes of low light sensitivity, and were known to have inferior image quality and were known to face fabrication challenges and other technical/performance issues related to CMOS imagers as compared to CCD imagers, would have demotivated one of ordinary skill in the subject art in the early 1990s against use in automotive applications of CMOS imaging sensors as disclosed and claimed in the '447 patent. This is at least because one of ordinary skill in the subject automotive art would be cognizant and aware of the real-world demands on and expectations for an automotive backup camera that include backing-up during low ambient light levels at night, that include that drivers/consumers of automobiles expect and demand good quality display of video images on par with what they have grown accustomed to via TV and via using their automotive mirrors, and that include that drivers/consumers of automobiles expect

and demand a backup camera be economically provided at a price affordable/attractive to the consumer and that the part be reliable and robust, and not fail, over the full multi-year life of the equipped vehicle through all seasons and driving conditions.

Faced with such known problems with CMOS technology in the early 1990s, the skilled artisan would be demotivated to even think of using CMOS, as the state of mind back then was that, given that it was in its infancy and given its then know problems, use of a CMOS imager for an automotive imager or automotive application would not be successful. Thus, in the early 1990s, the conventional wisdom among skilled artisans would have been that it would be unreasonable to try to use a CMOS imager for an automotive rear backup application and that it would be unlikely to succeed even should one think to use a CMOS imager for the likes of an automotive backup camera. A1438-39¶91.

Thus, Appellant respectfully submits that Wang, either alone or in combination with JP '889 and/or JP '700 or any other cited art, does not disclose or suggest the provision of a rearward vision system comprising a CMOS imaging array, collectively and in combination with the other claim elements of claim 45. Nor has the Board provided a reason that reasonably would have prompted one of ordinary skill in the art to have arranged all of the claim elements in the manner

necessary to arrive at the claimed invention. The Board seems to rely on the fiction that all vision systems are equal. *See* A5.

Here, not only is there no disclosure or suggestion in the applied art of providing a CMOS imaging array (collectively and in combination with other claim elements) for *any* vehicular application, more particularly for a rearward vision system of the types claimed herein, but clearly no reason has been provided that would have prompted a skilled artisan to combine the elements of Wang with JP '700, JP '889, or any other cited reference to arrive at the presently claimed invention. Moreover, the submitted evidence shows secondary considerations, specifically, evidence of commercial success of the claimed invention, long felt but unsolved need in the art, teaching away from the claimed invention by the prior art, recognition of a problem to be solved by the claimed invention, licensing of the claimed invention and copying of the claimed invention by others, further augment the novelty and non-obviousness of the claimed invention of patent claim 45. A1358-59. *See also KSR International Co. v. Teleflex Inc. et al.*, 550 U.S. 398 (2007), and *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1 (1966). Thus, Appellant submits that the applied art does not disclose or suggest or render obvious the use of a CMOS imaging array, collectively and in combination with the other claimed elements of independent claim 45.

2. In the Early 1990s, a CMOS Automotive Camera was Not a Familiar Element in the Relevant Art

The Examiner asserted that it would have been obvious to one of ordinary skill in the art at the time of the invention to substitute a known familiar element. A1470 (*citing KSR International Co. v. Teleflex Inc.*, 550 U.S. 398 (2007)); A1472 (*relying* on the Board opinion rendered in the previous reexamination, rather than the latest reexamination with further objective evidence unavailable to the previous Board and *de novo* reexamination). However, at the time of the '447 patent, a CMOS camera was ***not*** a familiar element as asserted by the Examiner. At the time of the '447 patent (early 1990s), CMOS cameras were still in their infancy (A1407-08¶31, A1413¶38, A1431-32¶75, and A1438-39¶91) and, prior to the innovative breakthrough, were not known or even considered for use in the automotive field relevant to the '447 patent invention. A1413-14¶¶38-40, A1436-39¶¶82, 83, 86-88, 91-92.

3. Wang does Not Teach or Point to an Automotive Application

Wang makes absolutely no teaching or suggestion of using a CMOS camera in any automotive application. Appellant submits that, there being no teaching or suggestion or motivation in Wang to use CMOS technology in an automotive application as erroneously contended by the Examiner, one of ordinary skill in the art at the time of the '447 patent would not have been led or motivated to combine

the teachings of Wang with the likes of JP '700 and/or JP '889 to arrive at claim 45 of the '447 patent. *See* A1399-1400¶7.

Back in the early 1990s, CMOS imagers were still relatively in their infancy and were known to exhibit the likes of low light insensitivity, and were known to have inferior image quality, and were known to face fabrication challenges and other technical/performance issues. A1413¶38, A1438-39¶91. Given such uncertainty, far from being motivated to use a CMOS imaging sensor for a safety-critical automotive application (such as claimed in the '447 patent), one of ordinary skill in the subject art in the early 1990s would have been demotivated against use in automotive applications of CMOS imaging sensors in the manner (for backup cameras) such as is disclosed and claimed in the '447 patent. A1438-39¶91. Indeed, faced with such known problems with CMOS technology in the early 1990s, the skilled artisan would be demotivated to even think of using CMOS (A1408-09¶32), as the state of mind back then was that, given that CMOS technology was in its infancy and given its then known problems, use of a CMOS imager for an automotive imager would not be successful in safety-critical automotive applications. A1438-39¶91. Plainly, one of ordinary skill in the art at the time of the invention would not have employed the teachings of Wang in such a safety-critical application as a rear backup camera for a vehicle, and given the then known drawbacks and challenges with CMOS

technology, would not reasonably have expected to succeed in such a safety-critical automotive application.

4. To be Safe and Successful, an Automotive Rear Backup Camera Must Operate at Night

Nighttime is a low light condition. An automotive rear backup camera that is insensitive in low light conditions will neither be safe nor commercially successful because it cannot be adequately operated at night. The Board improperly dismissed evidence that prior automotive vision systems failed to satisfy at night. A6-7. The Examiner blindly stated "the drawbacks such as low light opined by declarant Lynam does not make the combination inoperative." A1475. Firstly, Dr. Lynam has not "opined", he has declared, based on him being at least one of ordinary skill in the art at the relevant timeframe, that then known CMOS imagers exhibited low light insensitivity.

Moreover, Wang is silent on overcoming low light insensitivity, which would leave the skilled artisan at the time of the '447 patent unable to solve the then known low light insensitivity problem of CMOS imagers. Indeed, Wang gives no indication or guidance that such could ever be solved to the degree required for CMOS imagers to be operative for use as automotive backup cameras. It was Schofield who went against this grain. *See, e.g.*, A1408-14¶¶32-40, A1431-34¶¶75-79, A1435-39¶¶81-92, and A1387. The likes of cost, size and power consumption count for little to

nothing if the CMOS backup camera cannot "see" adequately when the vehicle is reversing at night.

The Board followed the Examiner's assertion that Wang taught away from the submitted evidence. A8. If indeed Wang taught away, what explanation can or does the Board offer for the fact that use of CCD cameras for the likes of automotive backup cameras continued to dominate and lingered for years (A1439¶92) after the early 1990s and that as late as 2005, CCD cameras were still a major part of the automotive rear backup market (A1409-10¶35) or that as late as 2009, around 54 percent of automotive cameras used globally were still reported to be CCD cameras? A1414.

Evidence shows that the inventor, Schofield, made the link in the early 1990s between what was then still emerging / "experimental" CMOS imaging and use in safety-critical automotive backup cameras. A1411-12¶37. Dr. Lynam attests that at the relevant timeframe, skilled artisans would have been motivated to continue with CCD cameras and that it was Schofield who then went against the grain of conventional thinking on CMOS imagers. A1408-09¶32, A1411-12¶37, and A1439¶92. That Schofield pioneered in this field is amply corroborated by the actions taken, indeed needed to be taken given CMOS imaging was then still emerging, "experimental" technology (A1411-12¶37), and as further corroborated by the media accolades Schofield/Donnelly received for blazing a trail in the early

1990s that led to the commercial development of CMOS automotive backup cameras and that led to their deployment today on millions upon millions of vehicles worldwide.

5. In the Early 1990s, Schofield Was a Pioneer and Pathfinder

Clearly, in the early 1990s, CMOS imagers were in their infancy, and Schofield was the pioneer and pathfinder that brought CMOS imaging to the applications taught and claimed in the '447 patent. The real-world evidence, supported in the Appeal Brief and in Dr. Lynam's declaration by objective articles and literature, (A1408-14¶¶32-40, A1431-39¶¶75-79, 81-92, A1387) show that the art before the '447 patent was scant to nothing and that the art following the '447 patent was a relatively slow acceptance of CMOS camera technology within the automotive industry. A1434-35¶80, A1436¶¶82-83, A1438-39¶¶88, 91. Clearly, this evidences that Schofield was a pathfinder via his innovation in being the first to deploy CMOS technology into the subject automotive application.

6. Dr. Lynam's Declaration Deserves Substantial Weight

Appellant has provided a declaration of one of skill in the art at the time of the invention, and that declaration includes a plethora of real-world objective evidence that evidences that, at the time of the '447 patent, CMOS cameras of the type described in Wang were not considered for automotive use as taught and claimed in the '447 patent. Yet the Board fails to properly weigh this and simply asserts that it would be obvious to make the combination. *See In re Rinehart*, 531

F.2d 1048. Dr. Lynam's declaration defines one of ordinary skill in the art at the time of the '447 patent and Dr. Lynam attests that he was at least one of ordinary skill in the art at that time. A1399-1400¶7. Yet the Board and Examiner ignores this because of his employment and contends that Dr. Lynam's positions are wrong and then the Examiner simply combines the art using the '447 patent as a template. Dr. Lynam attaches exhibits that include photographs taken at dealerships, and includes articles and publications. A1408-14¶¶32-40, A1329, A1336, A1372, A1387; *see also* A1559-60. Individually and collectively, these exhibits and publications deserve their proper consideration and weight when arriving at a determination of obviousness or non-obviousness.

The Board lists three factors pertinent in weighing the probative value of an expert opinion. A6-7. Regarding the first factor, Appellant respectfully traverses that the Board has come forth with strong opposing evidence to the copious objective evidence (backed by articles and citations) brought forth by Dr. Lynam.

Regarding the second factor, Dr. Lynam clearly and with candor has included in his declaration that he has been working at the patent owner since 1980 and he has further attested that he was familiar with the state of the art as of the early 1990s, that he was familiar with the extensive experimentation and testing undertaken by Schofield, and that he was at least a skilled artisan during the relevant timeframe.

A1399-1400¶7, A1401¶12. Dr. Lynam has attested that he is an employee of the patent owner. He has not declared he is the patent owner.

Regarding the third factor, Appellant respectfully traverses that the Dr. Lynam's arguments are premised largely on opinion versus fact.

7. Reasonable Expectation of Success Needs to be Gauged as of the Early 1990s

Safety is safety, whether in the early 1990s or today. A rear backup camera that exhibited the then known drawbacks of CMOS imagers (low light insensitivity, inferior image quality, difficulty in fabrication, etc.) would hardly have a reasonable expectation of success. A1408-09¶32, A1438-39¶91. That this was so is evidenced by the skepticism expressed by experts towards CMOS cameras and by automakers cleaving to CCD backup cameras into the late 1990s and beyond and now only relatively recently scrambling to utilize what Schofield pioneered. A1437-38¶¶86-88.

Further, and in the face of Appellant's submissions otherwise, the Board failed to provide required evidence or any prior art reference that shows that a CMOS camera, at the time of the ‘447 patent and when CMOS cameras were in their early development stage, would have been suitable for use in the backup automotive application of the '447 patent and/or would have been considered by one of ordinary skill in the art as a suitable replacement for a CCD camera. Thus, the Board failed to come forth with support for the contention that it would have been obvious to one

of ordinary skill in the art at the time of the '447 patent to combine the teachings of Wang with the teachings of JP '700 and JP '889 to arrive at the claimed invention. The Board simply failed to overcome the real world evidence provided in Dr. Lynam's declaration that such a combination simply was not considered until Schofield's innovative breakthrough. A1433-34¶78.

A published article discusses CMOS technology and "[r]ecently, new attention is paid to the development of image sensors based on CMOS technology, as an alternative for the CCDs." A1387. The publication (A1388-97) is dated December 22, 1997, and cites to another article dated October 1997 (Fossum, "CMOS Image Sensors: Electronic Camera-On-A-Chip", IEEE trans. on Electron Devices, vol. 44, no. 10, October 1997). These dates are years after the '447 patent, yet experts were still talking of paying "new attention" to CMOS image sensors. This is further real-world evidence that it took years ***after*** the filing of the Schofield application for others to begin to seriously consider replacement of CCD cameras with CMOS technology in automotive applications such as taught and claimed in the '447 patent.

8. The Board Inappropriately Weighed the Objective Evidence of Non-Obviousness Presented in the Appeal Brief[1]

The Board continues to inappropriately weigh the secondary considerations and objective evidence of non-obviousness and the declaration of Dr. Lynam. Dr. Lynam's declaration is supported by photographs of actual vehicles and systems, eight (8) articles published by third parties not related to Appellant, and dictionary definitions, none of which are "Dr. Lynam's opinion" and should be given fair consideration. *See* A1559-60; A1408-14¶¶32-40, A1329, A1336, A1372, A1387. Expert opinions based on fact are sufficient weight to rebut the prima facie case of obviousness. *See In re Oelrich*, 579 F.2d 86 (CCPA 1978).

Appellant cites to two articles (in support of the media and industry write-ups and accolades for Schofield's role in pioneering automotive CMOS image sensor applications. A1563 (citing http://findarticles.com/p/articles/mi_m3012/is_5_182/ai_87105901/ and Tom Murphy, Looking Back to the Future – How hard can it be to eliminate a driver's blindspot?, Ward's AutoWorld (May 1, 1998, 12:00 PM), http://waw.wardsauto.com/ar/auto_looking_back_future/; *see* A1407-08¶31 (discussing Kenneth Schofield's interactions with one of the Wang

[1] The evidence, including the cited publications and articles, were included *de novo* in the second reexamination and were not present in the previous reexamination of the '447 patent.

authors, Peter Denyer. Appellant submits that this is further secondary evidence of Schofield's pioneering work in the early 1990s. This is not "mere Lynam's opinion".

Furthermore, Dr. Lynam relied on scientific paper, dated December 22, 1997 and presented in 1998 at an IMEC Conference held in Berlin, Germany, addressing what is described (years after Schofield's pioneering usage of CMOS imagers for automotive applications) to be a novel usage of CMOS camera technology in automotive applications and citing (years after) to the likes of what Schofield taught in terms of the particular applicability of CMOS imagers in the automotive arena. *See* A1566-67; A1387. This is not "mere Lynam's opinion."

Further, and as previously submitted by the Appellant, Dr. Lynam cites to actual published skepticism from other experts in the automotive field even after the mid-1990s where the executive vice president at a competitor (clearly not an interested party to Appellant's success in this reexamination) to Appellant, who was commenting on automotive camera vision, expressed skepticism that CMOS imagers would be viable for use in automotive applications. (*See* A1567 (citing A1437¶86 relying on the 1998 Ward's Autoworld article (Murphy, supra). This is not "mere Lynam's opinion."

Yet in spite of all of the objective real-world evidence provided that corroborates that it would not have been obvious, at the time of the ‘447 patent, to combine Wang with JP '700 and/or JP '889, the Board maintains that such a

combination would be obvious, without providing proper support for making such a combination and without proper rebuttal of the evidence provided by Appellant, alleging that the evidence presented is an opinion.

It is also telling that in this its second reexamination request, and in spite of digging deep into the depths of prior art, the third party requester of this second reexamination again has failed (as has the Examiner himself) to come up with a single prior art reference that discloses or suggests use of a CMOS imager for an automotive application of any sort and particularly the applications taught and claimed in the '447 patent. Wang makes no disclosure or suggestion to use such a CMOS imager for an automotive application of any sort, and Wang is cumulative over the prior art that was examined during prosecution of the issued '447 patent claims. Moreover, the other cited art, including JP '889 and JP '700, clearly disclose use of television cameras or CCD cameras.

9. The Facts and Figures Given in the Lynam Declaration Stand at Odds with the Rejections

The Board asserts that the patent owner has not shown any commercial success actually attributable to the claimed invention. A9. This is incorrect. Dr. Lynam provides evidence attesting that Donnelly-supplied CMOS backup cameras represented an about 35 percent market share in North America in 2010, a year in which the patent owner shipped approximately 505,000 rear backup cameras to Ford and was Ford's 100 percent supplier. *See. e.g.*, A1436¶83. Appellant respectfully

points out that usage of systems by the millions on a wide variety of different vehicle models and brands is the epitome of commercial success in the automotive industry.

D. The Rejection of Independent Claim 107 Under 35 U.S.C. §103(a) Over JP '700, in View of JP '889

With respect to the rejection of independent claim 107, claim 107 includes the limitation that "wherein said pixelated array comprises a CMOS imaging array". The Board rejects this claim solely in view of the combination of JP '700 and JP '889. Clearly, there is no disclosure in JP '700 and JP '889 of a CMOS imaging array, particularly in combination with the other claim elements of independent claim 107. Thus, Appellant submits that the combination of JP '700 and JP '889 does not render obvious the claimed invention of independent claim 107. Plainly, and unequivocally, the Examiner's rejection of claim 107 must be reversed, if only on this ground. Further, Appellant submits that claim 107 is patentable over the prior art of record for at least the reasons set forth above

E. Secondary Considerations and Objective Evidence of Non-Obviousness

Appellant submits that features of the claims, such as those features discussed above, escaped the prior artisans, such as the prior artisans in 1983 working on the JP '889 disclosure and in 1987 working on the JP '700 disclosure. The evidence presented herein shows that one of ordinary skill in the art could not have arrived by known methods at the combination of features that collectively and combined together constitute the claimed invention as set forth herein, and this is evidenced by

the incorporation of the presently claimed features, and not those of JP '889 or JP '700, into the likes of the camera-based back-up systems on production vehicles today.

Moreover, given that prior artisans tried and failed in 1983 and 1987, the commercial and unique success of the presently claimed elements itself constitutes an unexpected result. Thus, Appellant submits that the JP '700 and JP '889 and Wang disclosures, in combination with the knowledge of one of ordinary skill in the art at the time of the invention of the '447 patent, lack a teaching or suggestion that would have led one of ordinary skill in the art to modify these references to arrive at the combination of features that collectively and combined together constitute the claimed invention of the claims set forth herein.

Further, Appellant submits that the inventions claimed in the '447 patent is the result of extensive experimentation and testing by Schofield to develop into the inventions that led to the '447 patent. As set forth in the Background to the Invention of the '447 patent, as of the early 1990s, camera-based rearview vision systems for vehicles had not obtained commercial acceptance on the likes of the vehicles illustrated in the drawings, and camera systems then known failed to provide to the driver important information where the information is most needed – at small separation distances from the surrounding objects.

Moreover, the teachings and claimed subject matter of the '447 patent have been important to the commercial success of such camera-based back-up systems with graphic overlays, as evidenced by the fact that vehicles at dealerships today function in the manner taught by Schofield and not in the manner taught by JP '889 or JP '700 (*see* A1348-51, A1355-58; A1373-83). Schofield's innovation of using a CMOS camera in a rearward vision system and providing electronic distortion correction in captured wide angle images and providing a graphic overlay that is indicative of a distance to an object rearward of the vehicle, while having the graphic overlay superimpose, upon moving the gear selector device to the "R" position, but with the vehicle yet to move in reverse, provides an inexpensive and effective solution to a longstanding problem.

JP '889 and JP '700 and the other prior artisans failed to see or solve the problems solved by the '447 patent, such as providing a graphic overlay to help guide a safe rearward maneuver from an initial stationary position of the vehicle, collectively and in combination with the other claimed features. Utilizing the claimed invention of the '447 patent, a driver, immediately upon moving the gear selector to select a reverse gear position, is presented with the graphic overlay and can readily judge, such as by utilizing the horizontal lines of the graphic overlay, distance to a rear positioned object or child before the vehicle moves at all. This aspect of the claimed invention of the '447 patent is now widely used on production

vehicles, and to Appellant's knowledge, the systems as taught by the likes of JP '889 and JP '700 have not achieved any commercial success. A1406¶28, A1420-21¶54.

1. Long Felt Need and Failure of Others

Appellant submits that, prior to the Schofield invention, rearward vision systems for vehicles utilized CCD cameras or television cameras. Dr. Lynam was, at the time of the invention, at least one of ordinary skill in the art, and is thus qualified to opine and attest as to the state of the art at the time of the Schofield invention and the novelty of the Schofield invention. A1399-1400¶7. For example, at the time of the Schofield et al. invention, the three inventors of the '447 patent (Schofield, Larson and Vadas) and Dr. Lynam were employed by Donnelly Corporation, and Dr. Lynam worked with all three inventors before, during and after the time of the Schofield invention, and Dr. Lynam was present at Donnelly and had direct first-hand experience of and exposure to the research and development work that led to the filing of the application that led to the '447 patent. A1399-1400¶7. Dr. Lynam also had first-hand experience of and exposure to the relevant state of the art before, during and after the time of the Schofield invention as such would have reasonably been known to a person of ordinary skill in the art relevant to this present reexamination.

Dr. Lynam has indicated that for years leading up to the early 1990s, the automotive industry had long-sought an economical and effective camera-based

backup system, and that this need was met by Schofield and is now deployed on the likes of many vehicles. *See* A1404¶¶23, 25; A1437¶85; A1355-57, A1372.

Prior to Schofield's innovation to use a CMOS imager in a vehicular vision system, the prior art taught use of CCD cameras or television cameras. The prior art cited in this reexamination, Wang, merely disclosed the existence of CMOS imagers. As discussed above, Wang is co-authored by Dr. Peter Denyer at the University of Edinburgh, Scotland, and the '447 patent discloses innovative automotive usage of CMOS imaging arrays of the type manufactured by VLSI Vision Ltd. of Edinburgh, Scotland. A28, 7:1-8. VLSI was a campus spin-off company from Dr. Denyer's work at the University of Edinburgh, and Donnelly became an investor in VVL in the early 1990s and did so because CMOS cameras were, in the early 1990s, neither used nor available for use in the automotive arena to automotive standards, requirements and expectations. Kenneth Schofield of Donnelly first recognized in the early 1990s that such types of CMOS imagers may have particular potential for use in automotive vision systems and he was a pioneer in the use of CMOS cameras in vehicles in general, and for camera-based backup aids in particular. A1407-08¶31.

The art at the time of the invention taught use of CCDs and away from CMOS, and the skilled artisan armed with JP '700 and JP '889 would have been motivated to use, and did use, CCD cameras. A1411-12¶37. The skilled artisan in the automotive industry in the early 1990s armed with Wang would see Wang to be an article from

university researchers and would not have made a link to potential use in automotive. It was only Kenneth Schofield who made such a link. Upon conceiving that CMOS imagers would have innovative deployment in the automotive arena, Kenneth Schofield contacted Dr. Denyer at the University of Edinburgh in Scotland, and when he so did it was because innovation was at work by Kenneth Schofield. Kenneth Schofield interacted with Dr. Denyer on what was as of the early 1990s a still-emerging image sensor technology, and Donnelly entered into a research and development program with Dr. Denyer/VLSI Vision Limited and Donnelly took an equity stake in VLSI Vision Limited. Such actions further corroborate and evidence that Schofield pioneered in the early 1990s the development and deployment of automotive CMOS imaging sensing systems, in order to satisfy a long felt need in the art. It took a flash of insight and ingenuity on Kenneth Schofield's part to foresee that the likes of cutting-edge research emerging from a university located in Edinburgh, Scotland could be harnessed and used (as it is today by the millions) for automotive imaging applications. A1411-12¶37. It was Schofield who innovated and pioneered this.

Furthermore, Dr. Denyer founded and served as chief executive officer of VLSI Vision Ltd. from its inception in 1990 through its flotation as Vision Group plc in 1995 and its growth and sale to STMicroelectronics in 1999. A1411-12¶37. Kenneth Schofield's worked with the Board of VLSI Vision Ltd to pioneer

commercialization of automotive applications for CMOS imager technology such as taught in the '447 patent. In the 1990s and into the 2000s, Kenneth Schofield received media and industry write-ups and accolades for his role in pioneering automotive CMOS image sensor applications. In 2008, Dr. Denyer and collaborators David Renshaw and Chinese scientists Lu Mingying and Wang Guoyo were awarded the Rank prize for their contribution to mobile phone technology, further corroborating that deployment of CMOS technology was a relatively recent bloomer in the camera imaging arena. These real-word facts evidence that invention was at work via Schofield's early 1990s pioneering work to use CMOS imagers in the automotive arena. A1411-12¶37 citing http://findarticles.com/p/articles/mi_m3012/is_5_182/ai_87105901/ and Murphy, supra.

The automobile industry did not use CMOS cameras until pioneered by Schofield. A1408-09¶32. At the time of the Schofield inventions, and until only relatively recently, automotive imagers mostly were CCDs, such as are clearly disclosed in the art applied in the Office Action. At that time period, CMOS cameras were not seen to be the tool of choice, but with the foresight and innovative development done by Schofield, CMOS cameras have now emerged that are suitable for use, and are now widely used, on automobiles. A1408-09¶32.

During the early 1990s, such CMOS imagers were still relatively in their infancy and the likes of low light sensitivity, inferior image quality, fabrication

challenges and other technical/performance issues related to CMOS imagers as compared to CCD imagers mitigated against an expectation of success of use of CMOS imaging sensors as disclosed and claimed in the '447 patent. A1413¶38. In the early 1990s, CMOS camera technology was only emerging and Kenneth Schofield, one of the inventors of the Schofield '447 patent, was recognized in the early 1990s as a pioneer in the use of CMOS camera technology in automotive vision systems. A1433-34¶78.

This is at least because one of ordinary skill in the subject automotive art would be cognizant and aware of the real-world demands on and expectations for an automotive backup camera that include backing-up during low ambient light levels at night, that include that drivers/consumers of automobiles expect and demand good quality display of video images on par with what they have grown accustomed to via TV and via using their automotive mirrors, and that include that drivers/consumers of automobiles expect and demand a backup camera be economically provided at a price affordable/attractive to the consumer and that the part be reliable and robust, and not fail, over the full multi-year life of the equipped vehicle through all seasons and driving conditions. Faced with such known problems with CMOS technology in the early 1990s, the skilled artisan would be demotivated to even think of using CMOS as the state of mind back then was that, given that it was in its infancy and

given its then know problems, use of a CMOS imager for an automotive imager or automotive application would not be successful.

Thus, in the early 1990s, the conventional wisdom among skilled artisans would have been that it would be unreasonable to try to use a CMOS imager for an automotive rear backup application and that it would be unlikely to succeed even should one think to use a CMOS imager for the likes of an automotive backup camera. A1438-39¶91. Wang states that "Camera and vision systems of today's CCD technology appear cumbersome, power-hungry and expensive." A297.

Yet, use of CCD cameras for the likes of automotive backup cameras continued to predominate and lingered years after the early 1990s. A1439-14¶¶39-40; A1436¶83. Thus, notwithstanding Wang's description above of "today's" CCD technology, it was Schofield alone in the early 1990s who went against the grain of then conventional thinking on CMOS imagers (that they are insensitive to low light, that they deliver inferior image quality and that they are challenging/costly to fabricate), and it is the industry at-large that cleaved to CCD automotive backup cameras and only belatedly copied and followed Schofield as the market data indicates, and did so skeptically and slowly. A1439¶92.

2. Skepticism of Experts

In spite of the conventional wisdom of using CCDs or television cameras for vehicular vision system applications, Schofield et al. proceeded against the accepted

wisdom of the experts. The "beliefs of those in the field at the time ... are the position from which the decisionmaker must view the invention." *Arkie Lures, Inc. v. Gene Larew Tackle, Inc.*, 119 F.3d 953, 957 (Fed. Cir. 1997). Moreover, the "evidence that the combination was not viewed as technically feasible must be considered, for conventional wisdom that a combination should not be made is evidence of unobviousness." *Id.* at 958 (*citing In re Hedges*, 783 F.2d at 1041 that proceeding against accepted wisdom is evidence of unobviousness).

In the early 1990s, one of ordinary skill in the subject art would have viewed CMOS imager technology to be insensitive in low light conditions (and thus not particularly suitable for use as a rear backup camera at night), to have inferior image quality and to be difficult and costly to make. These would motivate such artisans not to think of or use CMOS imagers, and would motivate them to cleave to CCD imagers for automotive applications (as indeed they did). A1408-09¶32.

Indeed, even well after the filing of the priority application to the '447 patent, experts held that the mainstream technology for image sensors was (as of 1997) based on the principle of CCDs. For example, a paper presented in 1998, years after Schofield's pioneering usage of CMOS imagers for automotive applications, discussed CMOS camera technology in automotive applications and cited to several of what Schofield taught in terms of the particular applicability of CMOS imagers in the automotive arena. A1387. By advocating and adopting CMOS camera

technology in the early 1990s, Schofield went against the grain and counter to then conventional thinking that led artisans to television cameras or CCD cameras for automotive use. A1408-09¶32. As late as December 1997, experts were acknowledging that in an automotive application, some of the major operation conditions of the sensor are really pushed to the limit. *See* A1387.

As was reported in and is evidenced by the IMEC article dated December 22, 1997 (*see* A1387), in an automotive application some of the major elements of the sensors are pushed to their limits. Thus, it is not surprising that, until Schofield paved the way for others to follow, the conventional thinking in the early 1990s by skilled artisan was to use television cameras/CCD cameras for automotive applications. A1409¶34, A1387.

That there was skepticism from other experts in the automotive even after the mid-1990s is evident at least from a 1998 Ward's Autoworld article where the executive vice president at a competitor to Appellant, commenting on automotive camera vision, expressed skepticism. A1437¶86, citing Murphy, supra.

Appellant's introduction and promotion of CMOS-based imagers for use on automobiles was seen to be pioneering, and other automakers (and especially Japanese automakers) waited for some years for CMOS backup cameras to prove reliable on vehicles by being so proven by real-life usage in the field through all seasons and climates. *See* A1436¶82. It is both remarkable and telling that no

automotive CMOS prior art came before Schofield, but a flood followed, albeit beginning a considerable time after Schofield, given the prevailing and lingering skepticism and doubt by automotive experts as to the utility and usefulness of CMOS imagers for automotive use in general and for automotive backup cameras, such as disclosed and claimed in the '447 patent, in particular.

Accordingly, Appellant respectfully submits that that the record is replete with compelling independent objective evidence that, at the time of the invention and even after, experts in the field were skeptical that the likes of the Schofield preferred CMOS imaging array would be suitable for vehicular vision system applications such as described in the '447 patent. Such expressions of disbelief by experts constitute strong evidence of non-obviousness. *Environmental Designs, Ltd. v. Union Oil Co. of California*, 713 F.2d 693, 697-698 (Fed. Cir. 1983); *see also U.S. v. Adams*, 383 U.S. 39, 52 (U.S. 1966).

3. Unexpected Results

The '447 patent specification itself and Dr. Lynam's declaration evidence that much of what Schofield et al. discovered prior to the priority filing in 1993 was surprising and unexpected. The industry believed that CCD cameras were best suited for automotive applications, as discussed above. CMOS cameras were not believed to be suited for such automotive applications because, back then in the early 1990s, such CMOS imagers were still relatively in their infancy and the likes of low light

sensitivity, inferior image quality, fabrication challenges and other technical/performance issues related to CMOS imagers as compared to CCD imagers mitigated against an expectation of success of use of CMOS imaging sensors as disclosed and claimed in the '447 patent. A1413¶38.

Contrary to what others expected, Schofield discovered that CMOS imaging arrays could be implemented in vehicular vision systems in accordance with the claimed invention, which surprisingly provided the successful commercial embodiments just now coming into their own. A1438¶90.

4. Copying

Appellant also submits that several competitors have copied the claimed invention of the '447 patent and, in an attempt to freely use the claimed invention (the same invention that the third party requester did not even request reexamination of in the first reexamination of the '447 patent), the third party requester requested a second reexamination of the '447 patent. "Another indicia of non-obviousness of a product is the acclamations it receives when it is released, and the copying that occurs." *Ecolochem, Inc. v. Southern California Edison Co.*, 227 F.3d 1361, 1380 (Fed. Cir. 2000). Evidence shows photographs of various rearward vision systems that copy claimed inventions of the '447 patent. A1329, A1336, and A1372.

"[C]opying requires the replication of a specific product. This may be demonstrated either through internal documents . . . ; direct evidence such as

disassembling a patented prototype, photographing its features, and using the photograph as a blueprint to build a virtually identical replica . . . ; or access to, and substantial similarity to, the patented product (as opposed to the patent)". *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1325 (Fed. Cir. 2004) (internal case cites omitted). In this case, there is no doubt that the third party copiers had access to the products manufactured in accordance with the claimed invention, since these products were initially developed by Appellant, and were incorporated in commercially available vehicles on the road.

Only a relatively small number of automakers (often in the industry referred to as Original Equipment Manufacturers or "OEMs"), and there is an even smaller supply base for vehicles, and in particular, for vehicular rear backup cameras, and this supply base is highly competitive. A1435-36¶81. The respective competitors closely monitor each other's products and technologies, and reverse engineering and competitive benchmarking are commonplace. The program life of a vehicle model is about 5 to 7 years or thereabouts, and about 1 to 2 years or thereabouts before a new vehicle model is to be introduced, the automaker solicits bids from its supply base (as indicated above, typically a handful of competing suppliers). There is thus only limited opportunity to bid for programs as requests from automakers to bid come along typically only when new models are being planned at OEMs.

Performance to OEMs expectations includes that the part supplied will be reliable throughout its lifetime of usage on the vehicle through all seasons and climates year after year. The OEM automaker does not want to experience warranty returns, most definitely does not want to experience product recalls or product liabilities, wants the owner of the vehicle to be satisfied with the performance/quality, and wants the supplied part to help the OEM compete against other automakers when it comes to vehicle purchase at dealerships. In terms of business awards by automakers, advertising or the like does not play a role in winning business at automakers.

Donnelly's introduction and promotion of CMOS-based imagers for use on automobiles was seen to be pioneering, and other automakers (and especially Japanese automakers) waited for some years for CMOS backup cameras to prove reliable on vehicles by being so proven by real-life usage in the field through all seasons and climates. A1436¶82. That others now scramble to copy what Schofield pioneered is evident from the market data given above showing that usage of automotive CMOS imager sensors is growing to dominate the market and is heading to eclipse CCD image sensors. CMOS automotive cameras already constitute a significant market share, as evidenced herein. A1438¶88.

There can be no legitimate question that the vision systems of Lynam Exhibit C include claimed elements, including a CMOS imaging array, nor can there be any

legitimate question that a nexus exists between the merits of the claimed invention and the evidence of copying. MPEP 716.01(b); *See also Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 305 n.42 (Fed. Cir. 1985), *cert. denied*, 475 U.S. 1017 (1986).

5. Commercial Success

Commercial success is presumed when a patentee can demonstrate that there are significant sales in a relevant market and that the successful product is the invention disclosed and claimed in the patent. *Ormco Corp. v. Align Technology Inc.*, 463 F.3d 1299, 1312 (Fed. Cir. 2006). (stating "As we explained in *J.T. Eaton & Co. v. Atlantic Paste & Glue Co.*, 106 F.3d 1563 (Fed. Cir. 1997), '[w]hen a patentee can demonstrate commercial success, usually shown by significant sales in a relevant market, and that the successful product is the invention disclosed and claimed in the patent, it is presumed that the commercial success is due to the patented invention.' *Id*. at 1571"); *see also Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1130 (Fed. Cir. 2000) (stating the presumption that commercial success is due to the patented invention applies 'if the marketed product embodies the claimed features, and is coextensive with them.')). The commercial success of the vision systems manufactured in accordance with the claimed invention of the '447 patent is directly derived from the invention claimed.

The Board states that the evidence of commercially available rear-vision camera systems does not show that the systems were commercially successful. The A9. However, this is contradictory to the evidence submitted that shows that the systems in production today practice the claimed invention of the '447 patent and not the prior art. Appellant submits that it is the production and sales of the claimed invention across several vehicle manufacturers and vehicle product lines that evidences the substantial commercial success of the claimed invention. Automakers are notoriously cost conscious and have the choice for a lower price of not using graphic overlays/guidelines and other elements of the claimed invention. Plainly, that so many vehicles across so many automakers are at dealerships today with the rear vision system and graphic overlay and CMOS imaging devices and other features as claimed is clear and convincing evidence of commercial success with a straight nexus with the claim elements.

As set forth in Dr. Lynam's declaration and its exhibits, the presently claimed invention is the subject of vision systems in production today across several vehicle manufacturers and several vehicle product lines or models. If the claimed invention were not commercially successful, then vehicle manufacturers would include vision systems that do not incorporate the claimed invention. But instead, vehicle manufacturers include vision systems made in accordance with the claimed invention of the '447 patent.

CMOS imagers now represent around 90 percent, by unit, of all imaging sensors used world-wide, whereas even some after time of invention of Schofield's inventions, they represented less than 10 percent. A1436¶83. In the automotive market, CMOS-based rear backup cameras were not commercialized until after 1995 and Donnelly pioneered and led this growth. A1436¶83.

To take an illustrative example, 100 percent of the rear backup cameras used by Ford Motor Company in North America are supplied by Appellant with CMOS imagers. A1436¶83. In calendar year 2010, Appellant shipped approximately 505,000 CMOS rear backup cameras to Ford, all with graphic overlays that comport with the '447 patent, all with optical correction for image distortion and many with electronic correction for image distortion. Ford Motor Co. vehicle production in 2010 is reported to be around 2.3M vehicles, and overall, Appellant shipped around 765,000 CMOS backup cameras in 2010, representing an about 35 percent market share for rearview vision systems produced in North America in 2010. This represents a substantial quantity in the North American market for such rearview vision systems. A1436¶83.

Ford and other OEMs had the desire to use the proven performance of the same technology taught and claimed by Schofield, not merely to increase the popularity of a particular vehicle model or the effectiveness of the marketing efforts employed, which drove Appellant's commercial success in winning such a large

commercial market share. A1436-37¶84. There is a clear nexus between the claimed subject-matter of the '447 patent, including the likes of use of a CMOS imager and use of electronic image distortion and use of particular types of graphic overlays, and the commercial success Appellant has had with products based on what is disclosed and claimed in the '447 patent.

As indicated above, OEMs have choice in what they buy and are price conscious and OEMs will only add the features such as are included in what Appellant sells and ships to them based on performance and on what such features do. The likes of advertising and the like play little to no role in winning a purchase order from an OEM for a rear backup camera. It was because Ford wanted what is included in Appellant's cameras that Ford placed its purchase orders with Appellant, and what Ford wanted included use of a CMOS imager and use of electronic image distortion correction and use of those types of graphic overlays with distance indication as taught and claimed in the '447 patent. A1436-37¶84.

It is estimated that CMOS sensors accounted for just 7.2 percent all image sensors shipped in 1999. A1413-14¶39 citing CMOS Marketing Opportunity, http://www.siliconimaging.com/cmos_market_opportunity.htm. Thus, years after Schofield's inventions, CCD sensors still vastly dominated and were the tool of choice for imaging applications, and especially in automotive applications. In 2001, industry experts were still discussing the potential of CMOS imagers and the then

impeding demise of the then incumbent image-sensing technology, CCD. A1413-14¶39 citing http://www.siliconimaging.com/cmos_market_opportunity.htm. This further evidences that Schofield's foresight in the 1990s with regard to automotive use of CMOS sensors was innovative and pioneering. Now, nearly two decades after Schofield's innovations in the automotive sphere made in the early 1990s, CMOS image sensors in 2010 are reported to around 90 percent of the unit share of the market, with automotive applications cited as one of the factors driving this growth in usage of CMOS image sensors over CCD image sensors. A1413-14¶39 citing Carrie Meadows, iSuppli: CCDs fall in image sensor market as CMOS surges, Vision Systems Design (Oct. 2010), http://www.vision-systems.com/articles/2010/10/isuppli-image-sensors-market-2010.html.

Schofield's innovative pioneering in the early 1990s of CMOS automotive cameras is further evidenced where it is reported that out of the around 7.8 million automotive cameras used globally in the automotive market in 2009 (well over a decade after Schofield's pioneering of CMOS automotive camera applications), the majority (around 4 million units; 53.5 percent share) remained CCD cameras but with most of the remaining (around 3.5 million units; 46 percent share) being CMOS cameras. A1414¶40 citing Automotive Camera Analysis 2010, Techno Systems Research Co. Ltd. And it is of further testament to Schofield's pioneering innovative applications of the early 1990s (that now are coming of age) that it is also estimated

that by 2015, the share held by CCD cameras of the automotive cameras market total will fall to only around 2.5 percent whereas the share held by CMOS cameras of the automotive cameras global market total will rise to about 95 percent. A1414¶40.

The commercial success of Schofield's use of a CMOS imaging array in vehicle vision systems is thus unassailable. An element of that success is the third party copying of the '447 patent rearward vision system, such as discussed above.

That others now scramble to copy what Schofield pioneered is evident from the market data given above showing that usage of automotive CMOS imager sensors is growing to dominate the market and is heading to eclipse CCD image sensors, and CMOS automotive cameras now constitute a significant market share as evidenced herein. A1438¶88.

Appellant herein offers proof that the sales made by the third parties were a direct result of the unique characteristics of the claimed '447 patent invention - as opposed to other economic and commercial factors unrelated to the quality of the patented subject matter. *See In re DBC,* 545 F. 3d 1373, 1384 (Fed Cir. 2008) (stating "the proponent must offer proof 'that the sales were a direct result of the unique characteristics of the claimed invention - as opposed to other economic and commercial factors unrelated to the quality of the patented subject matter.' *In re Huang,* 100 F.3d 135, 140 (Fed. Cir. 1996); see also *In re GPAC Inc.*, 57 F.3d 1573, 1580 (Fed. Cir. 1995) ('For objective evidence to be accorded substantial weight, its

proponent must establish a nexus between the evidence and the merits of the claimed invention.')."") Appellant also respectfully submits that the evidence presented in the incorporated Lynam Declaration and Lynam Exhibits does far more than merely submit evidence of sales. The driving force behind those sales is clearly evidenced herein, and is reinforced by the copying undertaken by third parties to secure the vehicle orders.

The nexus between the merits of the '447 patent and third party vision system sales is clear and compelling. Dr. Lynam's Declaration factually attests to what he knew and did as of the early 1990s, and is supported with objective evidence and is not a conclusory opinion, and is replete with factual evidence.

6. Licensing of Others

As Dr. Lynam attests in his declaration, a major OEM requested and was granted a license to the '447 patent so that that OEM could access such claims. A1438¶89.

XI. CONCLUSION AND STATEMENT OF RELIEF SOUGHT

For at least the reasons set forth above, and as is apparent from examining the invention defined by the claims of the '447 patent when properly considering the cited references, these claims define patentable subject matter. Accordingly, Appellant respectfully submits that all of the claims at issue herein are patentable over the prior art references of record, and reversal of the Board decision and rejections of these claims under 35 U.S.C. §103 is appropriate and is respectfully solicited.

November 7, 2014

/s/ Terence J. Linn

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XII. ADDENDUM

UNITED STATES PATENT AND TRADEMARK OFFICE

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte MAGNA ELECTRONICS, INC.

Appeal 2013-004164
Reexamination Control No. 90/011,478
Patent 6,222,447
Technology Center 3900

Before HOWARD B. BLANKENSHIP, KEVIN F. TURNER, DAVID M. KOHUT, and STANLEY M. WEINBERG, *Administrative Patent Judges.*

KOHUT, *Administrative Patent Judge.*

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134(b) from the Examiner's rejection of claims 45 and 107[1] of United States Patent 6,222,447 (hereinafter "'447 Patent"). Final Office Action mailed February 24, 2012 (hereinafter "Final Action."). An oral hearing was conducted with the Patent Owner on April 24, 2013. A transcript of the oral hearing was made of record on July 19, 2013.

We have jurisdiction under 35 U.S.C. § 306.

We AFFIRM.

STATEMENT OF THE CASE

This *ex parte* reexamination proceeding was initiated by a "REQUEST FOR REEXAMINATION" filed on February 7, 2011, by William Mandir, Sughrue Mion, PLLC, attorney for a Third-Party Requester.

The '447 Patent describes a vehicular rearview vision system.

Claim 45 is illustrative of the invention and reads as follows:

> 45. A rearview vision system for a vehicle having a gear actuator, comprising:
>
> an image capture device mounted at the rear of the vehicle and having a field of view directed rearwardly of the vehicle, wherein said image capture device comprises a pixelated imaging array and wherein said pixelated array comprises a CMOS imaging array;

[1] Appellant withdraws claims 4, 32-37, 40-44, 46-56, 59-65, 67-79, 82-99, 102, 106, and 108-185 from consideration and asks the Examiner to cancel the claims without prejudice. Reply Br. 2. As such, we will not address any arguments directed toward these claims and also urge the Examiner to cancel the claims.

> a display system viewable by a driver of the vehicle which displays a rearward image output of said image capture device;
>
> a graphic overlayer superimposed on said rearward image when the gear actuator of the vehicle selects a reverse gear; and
>
> wherein said graphic overlayer is disabled when the gear actuator of the vehicle is not in reverse gear.

The following prior art references are applied:

Matsushita Electric Co.	JP 60-79889	Oct. 23, 1986
Aisin AW Co.	JP 64-14700	Jan. 18, 1989

G. Wang et al., *CMOS Video Cameras*, IEEE, pp. 100-103 (1991).

Appellant/Patent Owner appeals the Examiner's following rejection:

Claims 45 and 107[2] are rejected under 35 U.S.C. § 103(a) as obvious over the combination of JP 64-14700 (hereinafter referred to as "JP '700"), JP 60-79889 (hereinafter referred to as "JP '889"), and "CMOS Video Cameras" (hereinafter referred to as "Wang").

ISSUES

Did the Examiner err in finding that it would have been obvious to modify the system of JP '700 and JP '889 to use the CMOS camera taught by Wang instead of the CCD camera taught by JP '700 and JP '889?

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[2] Since Appellant withdrew claims 4, 32-37, 40-44, 46-56, 59-65, 67-79, 82-99, 102, 106, and 108-185 (Reply Br. 2) we have removed them from the rejection statement.

ANALYSIS

Claims 45 and 107

Claims 45 and 107 recite a "rearview vision system… wherein said image capture device comprises a pixelated imaging array and wherein said pixelated array comprises a CMOS imaging array." The Examiner adopted the Requester's proposed rejection of claims 45 and 107 over the combination of JP '700, JP '889, and Wang, evidenced by Kuban. Ans. 4; citing Final Office Action mailed February 24, 2012. Patent Owner argues that it would not have been obvious to one of ordinary skill in the art at the time of the invention to use the CMOS camera taught by Wang in place of the CCD camera taught by JP '700 and JP '889. We disagree with Patent Owner for the reasons discussed below.

Patent Owner argues that one of ordinary skill in the art would not have been motivated to use the CMOS camera of Wang in the automotive vision system of JP '700 and JP '889 because there is no "teaching or suggestion or motivation" in Wang to use the CMOS camera in an automotive vision system. Reply Br. 4. We disagree. Wang teaches that the CMOS camera is usable in "vision systems," a fact which tends to suggest that the CMOS camera is usable in any type of vision system, including in an automotive vision system. Wang, p. 100. Furthermore, even if Wang does not provide an explicit teaching, suggestion, or motivation to use the CMOS camera in an automotive vision system, the Supreme Court has held that a teaching, suggestion, or motivation in the prior art is but one of several rationales that may support a conclusion of obviousness. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 415-416 (2007). In *KSR*, the Court

held that "when a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a predictable result." *Id.* As evidenced by JP '700, JP '889, and Wang, CCD cameras and CMOS cameras were known in the field of vision systems at the time of the invention. In addition, using a CMOS camera instead of a CCD camera would have achieved the predictable result of reducing the size, cost, and power consumption of the camera used by the system of JP '700 and JP '889. Ans. 27; *see also* Wang, p. 100.

Nonetheless, Patent Owner provides the expert opinion of Dr. Lynam in an attempt to show that using the CMOS camera of Wang instead of the CCD camera of JP '700 and JP '889 would not have achieved predictable results. Appeal Br. 69. According to Dr. Lynam, "one of ordinary skill in the subject art in the early 90's would have viewed CMOS imager technology to be insensitive in low light conditions (and thus not particularly suitable for use as a rear backup camera at night), to have inferior image quality and to be difficult and costly to make." Lynam Decl. ¶ 32. We do not find Dr. Lynam's declaration persuasive. In assessing the probative value of an expert opinion, we must consider three factors: 1) the interest of the expert in the outcome of the case, 2) the presence or absence of factual support for the expert's opinion, and 3) the strength of any opposing evidence. *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776, F.2d 281 (Fed. Cir. 1985).

Regarding the first factor, Dr. Lynam was employed by Patent Owner when he provided the expert opinion and therefore has a substantial interest in the outcome of the case. Ans. 44; *see also* Lynam Decl. ¶¶ 1-5.

Regarding the second factor, there is little or no factual support for Dr. Lynam's expert opinion. For instance, neither Dr. Lynam nor Patent Owner has provided any information indicating the approximate level of light sensitivity needed by a backup camera to suitably operate at night,[3] the approximate level of light sensitivity of any known CMOS camera, the approximate cost and quality of any known CMOS camera, or the approximate cost and quality of any known CCD camera. Regarding the third factor, Wang provides substantial objective evidence that squarely contradicts Dr. Lynam's expert opinion. For instance, Wang teaches that known CCD cameras were "cumbersome, power-hungry and expensive" compared to Wang's CMOS camera. Wang, p. 100. In addition, when comparing the CMOS camera to known CCD cameras, Wang teaches that the "picture quality is subjectively excellent, and compares well with commercially available cameras." *Id.* at p. 101. Wang also provides a table of experimental results showing that the performance of the CMOS camera meets or exceeds the performance of known CCD cameras in a number of respects. *Id.* at p. 103. Based on our above analysis, we agree with the Examiner that the probative value of the objective evidence provided by Wang outweighs the probative value of Dr. Lynam's expert opinion. Ans. 44-46.

Patent Owner also contends that the prior art as a whole teaches the benefits of using CCD cameras in automotive vision systems and therefore teaches away from using CMOS cameras in such systems. App. Br. 67. We

[3] Taking into account ambient light sources such as buildings, street lamps, and vehicles (especially the rear lights of the vehicle employing the backup camera).

disagree. A teaching of a preferred embodiment does not constitute a teaching away from a non-preferred embodiment. *In re Gurley*, 27 F.3d 551, 554 (Fed. Cir. 1994). In addition, Patent Owner argues that using a CMOS camera in an automotive vision system would render such a system inoperable at night because CMOS cameras are insufficiently sensitive to low levels of light.[4] Reply Br. 5. However, Patent Owner has not shown that a CMOS camera-based automotive vision system would be completely inoperative at night or that one of ordinary skill in the art would not know how to modify the CMOS camera to work during the night. More to the point, Wang teaches that CCD cameras are "cumbersome, power-hungry and expensive" relative to Wang's CMOS camera. Wang, p. 100. Thus, there is motivation to use a CMOS camera in the place of a CCD camera since a CCD camera-based automotive vision system is too expensive, too bulky, and too power-hungry to be incorporated into a vehicle.

Evidence of Nonobviousness Based on Secondary Considerations

Patent Owner argues that there is substantial evidence of nonobviousness based on secondary considerations. Specifically, Patent Owner provides evidence of the following secondary considerations: 1) commercial success, 2) long-felt need and failure of others, 3) skepticism of experts, 4) unexpected results, 5) copying by others, and 6) licensing. The

[4] According to this logic, claims 45 and 107 are not enabled because the specification of the '447 Patent does not teach one of ordinary skill in the art how to overcome the allegedly known low light insensitivity of CMOS cameras.

evidence pertaining to each secondary consideration is separately discussed below.

Commercial Success

Dr. Lynam attests that CMOS camera-based automotive vision systems supplied by Patent Owner accounted for 35% of the North American market for automotive vision systems in 2010. Dr. Lynam also attests that CMOS cameras accounted for only 10% of the world-wide market for cameras shortly after the time of the invention and 90% at some point thereafter. Appeal Br. 108; Reply Br. 13; *see also* Lynam Decl. ¶ 83. The Examiner finds that Patent Owner has failed to establish that Schofield's use of a CMOS camera caused Patent Owner's 35% share of the market for automotive vision systems in 2010. Ans. 52. We agree with the Examiner. Patent Owner bears the initial burden of proving that there is a nexus between the claimed invention and the commercial success. *Ormco Corp. v. Align Tech., Inc.*, 463 F.3d 1299, 1311-12 (Fed. Cir. 2006). In the instant case, the automotive vision system of claims 45 and 107 comprises two features: a CMOS camera for generating rearview images and a graphic overlay superimposed on the images when a gear actuator of a vehicle selects a reverse gear. Patent Owner has failed to present evidence that Patent Owner's 35% share of the market for automotive vision systems in 2010 was due to the CMOS camera feature and not the graphic overlay feature. Furthermore, Patent Owner has not provided sufficient evidence of the notion that Schofield's use of CMOS cameras in one particular market sparked the commercial success of CMOS cameras in every other market.

Long-felt Need and Failure of Others

Again relying on the expert opinion of Dr. Lynam, Patent Owner argues that "for years leading up to the early 1990s, the automotive industry had long-sought an economical and effective camera-based backup system. Ans. 46; *see also* Lynam Decl. ¶¶ 23, 25, and 85. The Examiner finds that any long-felt need was satisfied by Wang. Ans. 52. We agree with the Examiner. Any long-felt need must not have been satisfied by another before the invention by Schofield. *Newell Companies v. Kenney Mfg. Co.*, 864 F.2d 757, 768 (Fed. Cir. 1988). As discussed earlier, the relevant field is that of vision systems, not automotive vision systems. To the extent there was a long-felt need in the field of vision systems for something cheaper, smaller, and less power-hungry than existing CCD camera-based vision systems, Wang satisfied that need by developing a cheaper, smaller, and less power-hungry CMOS camera-based vision system. Wang, p. 100. Furthermore, we are not persuaded that the camera-based backup systems of JP '700 and JP '889 did not satisfy the long-felt need.

Skepticism of Experts

Patent Owner argues that using CMOS cameras in automotive vision systems was not viewed as being "technically feasible" at the time of the invention because CMOS cameras were viewed as being insensitive in low light conditions, having inferior image quality, and being costly to make. Appeal Br. 102-103; *see also* Lynam Decl. ¶ 32. The Federal Circuit has held that "evidence that the combination was not viewed as technically feasible… is evidence of unobviousness." *Arkie Lures, Inc. v. Gene Larew Tackle, Inc.*, 119 F.3d 953, 958 (Fed. Cir. 1997). However, in *Arkie Lures*,

the Federal Circuit clarified that the term "technically feasible" refers to "manufacturing uncertainties" such as the potential for "violent explosions" that render the manufacturing process "unsafe."[5] 119 F.3d at 957. In the instant case, evidence of the low light insensitivity, poor image quality, and high cost of CMOS cameras at the time of the invention does not raise doubt that a CMOS camera-based automotive vision system can be manufactured.

Citing a 1998 "Ward's Autoworld" article, Patent Owner further contends that experts other than Dr. Lynam expressed concerns that it is "just too expensive" to use a CMOS camera in an automotive vision system at the time of the invention. Appeal Br. 103; *see also* Lynam Decl. ¶ 86. However, the expert in the article is merely stating that CCD cameras are too expensive for use in automotive vision systems. As discussed earlier, Wang addressed this problem by developing a vision system that uses a CMOS camera instead of a CCD camera. Wang, p. 100. In addition, even assuming that the article can somehow be construed as saying that CMOS cameras are too expensive for use in automotive vision systems, the cost of CMOS cameras is not by itself sufficient to discourage one of ordinary skill in the art from incorporating CMOS cameras into automotive vision systems for another reason, such as reduced size and/or power consumption as is taught by Wang. *Id. See also In re Farrenkopf*, 713 F.2d 714, 718 (Fed. Cir. 1983) ("additional expense associated with the addition of inhibitors would not discourage one of ordinary skill in the art").

---

[5] The invention at issue in *Arkie Lures* was a fishing lure manufactured using a combination of salt and plastic. Two manufacturers testified that "it is unsafe to mix chemicals such as salt with plastic, because such mixing can cause violent explosions." *Id.* at 955.

Lastly, Patent Owner argues that Japanese automakers waited for years after the invention to incorporate CMOS backup cameras into their vehicles because they were skeptical that CMOS backup cameras would prove reliable in real-life usage in the field through all seasons and climates. Appeal Br. 103; *see also* Lynam Decl. ¶ 82. However, Japanese automakers could have delayed not for reasons of reliability, but for economic reasons. That businessmen would not make a combination for economic reasons does not mean that persons skilled in the art would not make the combination because of some technological incompatibility. Only the latter fact would be relevant. *Orthopedic Equipment Co. v. United States*, 702 F.2d 1005, 1013 (Fed. Cir. 1983).

Unexpected Results

Patent Owner argues that by combining a CMOS camera with an automotive vision system, the inventor achieved the unexpected commercial success. Appeal Br. 104; *see also* Lynam Decl. ¶ 90. However, evidence of unexpected results must be evidence that the combination yields unexpectedly improved properties or properties not present in the prior art. *In re Dillon*, 919 F.2d 688, 692 (Fed. Cir. 1989). Accordingly, evidence of commercial success is not evidence of unexpected results.

Copying by Others

Patent owner contends that commercial products on the road today are substantial replicas of products made in accordance with the present invention. Appeal Br. 105-106; *see also* Lynam Decl. ¶¶ 81 and 88. However, Patent Owner has not provided sufficient evidence of copying that

is not based on conjecture, i.e., independent development or without knowledge of the '447 Patent.

Licensing

Patent Owner argues that a major OEM requested and was granted a license to the '447 Patent, but no specific evidence of such is presented. Appeal Br. 111; *see also* Lynam Decl. ¶ 89. Thus, we do not find Patent Owner's argument to be persuasive.

It follows that Patent Owner has not shown that the Examiner erred in concluding that it would have been obvious to modify the system of JP '700 and JP '889 to use the CMOS camera taught by Wang instead of the CCD camera taught by JP '700 and JP '889. As such, and for all of the reasons stated *supra* we sustain the Examiner's rejection of claims 45 and 107.

CONCLUSION

The Examiner did not err in finding that it would have been obvious to modify the system of JP '700 and JP '889 to use the CMOS camera taught by Wang instead of the CCD camera taught by JP '700 and JP '889.

SUMMARY

We affirm the Examiner's decision to reject claims 45 and 107 as obvious over the combination of JP '700, JP '889, and Wang.

Appeal 2013-004164
Reexamination Control No. 90/011,478
Patent 6,222,447

AFFIRMED

alw

PATENT OWNER:

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Exhibit A

US006222447B1

(12) **United States Patent**
Schofield et al.

(10) **Patent No.: US 6,222,447 B1**
(45) **Date of Patent: *Apr. 24, 2001**

(54) **REARVIEW VISION SYSTEM WITH INDICIA OF BACKUP TRAVEL**

(75) Inventors: **Kenneth Schofield**, Holland; **Mark L. Larson**, Grand Haven; **Keith J. Vadas**, Coopersville, all of MI (US)

(73) Assignee: **Donnelly Corporation**, Holland, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **09/313,139**

(22) Filed: **May 17, 1999**

Related U.S. Application Data

(63) Continuation of application No. 08/935,336, filed on Sep. 22, 1997, which is a continuation of application No. 08/445,527, filed on May 22, 1995, now Pat. No. 5,670,935, which is a continuation-in-part of application No. 08/023,918, filed on Feb. 26, 1993, now Pat. No. 5,550,677.

(51) **Int. Cl.**[7] **B60Q 1/00**

(52) **U.S. Cl.** **340/461**; 340/435; 340/436; 340/901; 340/903; 348/148; 345/7; 345/9; 701/300; 701/301

(58) **Field of Search** 340/461, 435, 340/436, 438, 901, 903; 348/118, 148; 345/7, 9; 701/300, 301, 302

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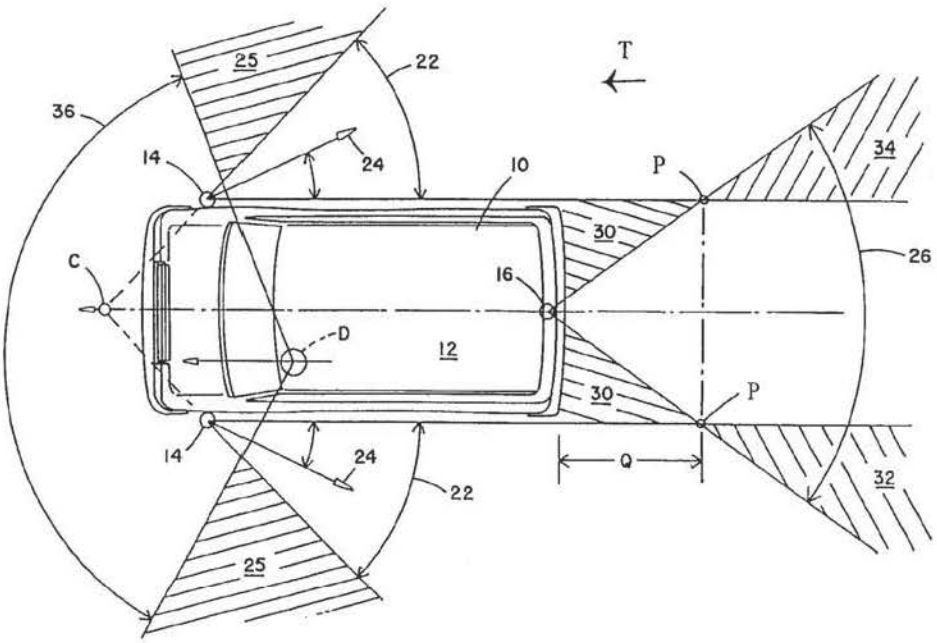
(57) **ABSTRACT**

A rearview vision system for a vehicle includes an image capture device mounted at the rear of the vehicle and having a field of view directed rearwardly of the vehicle. A display system is viewable by a driver of the vehicle. The display system displays a rearward image output of the image capture device. A graphic overlay is superimposed on the rearward image when the gear actuator of the vehicle selects a reverse gear. The graphic overlay may include indicia of the anticipated path of travel of the vehicle. The graphic overlay may be disabled when the gear actuator of the vehicle is not in reverse gear.

101 Claims, 7 Drawing Sheets



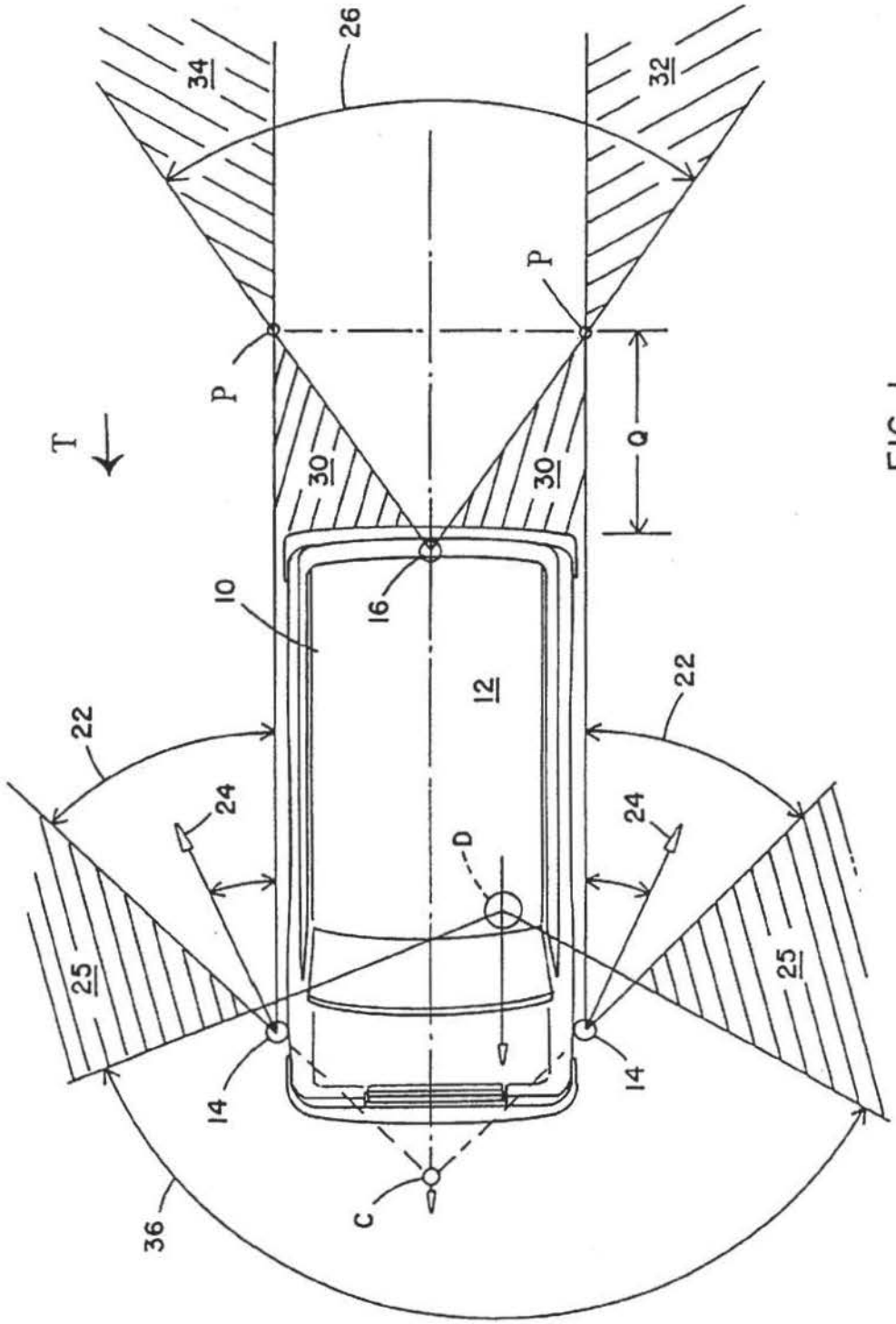


FIG. 1

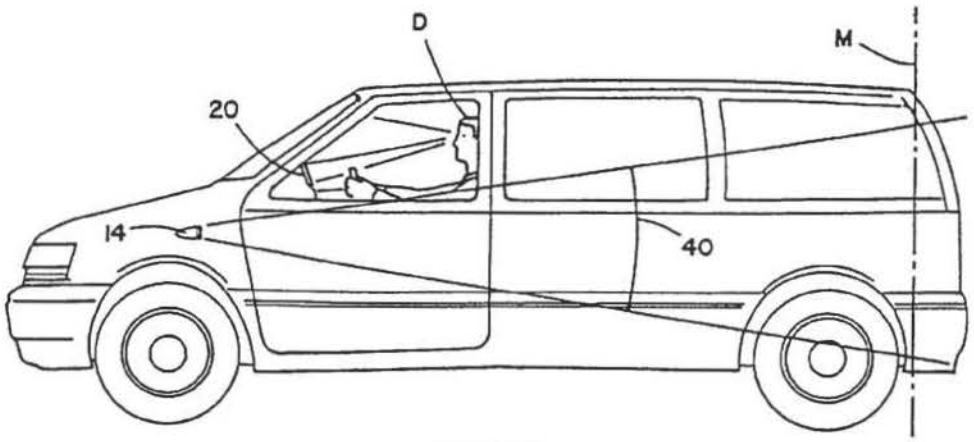


FIG. 2

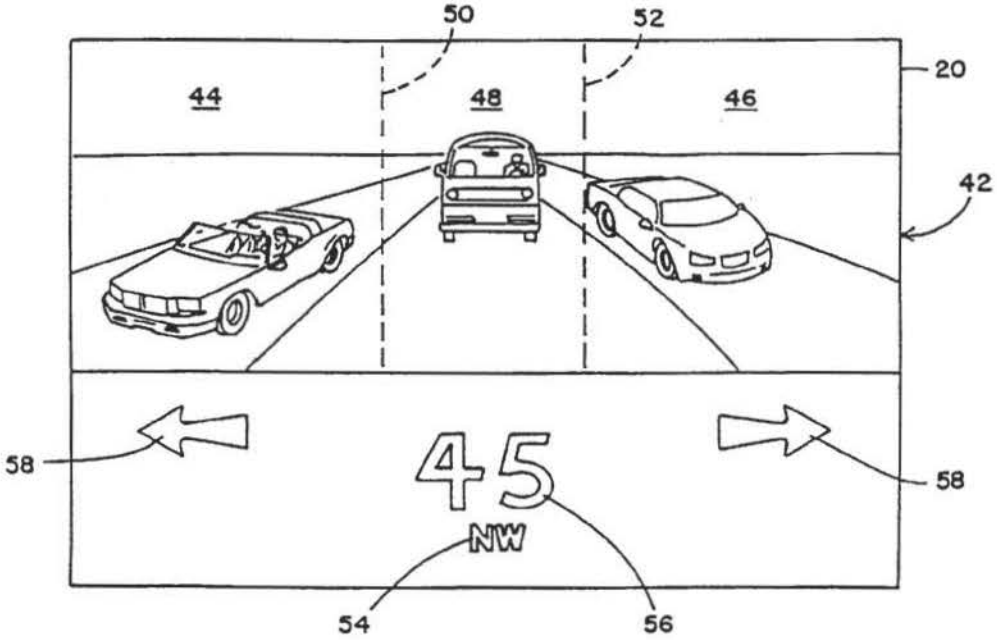


FIG. 3

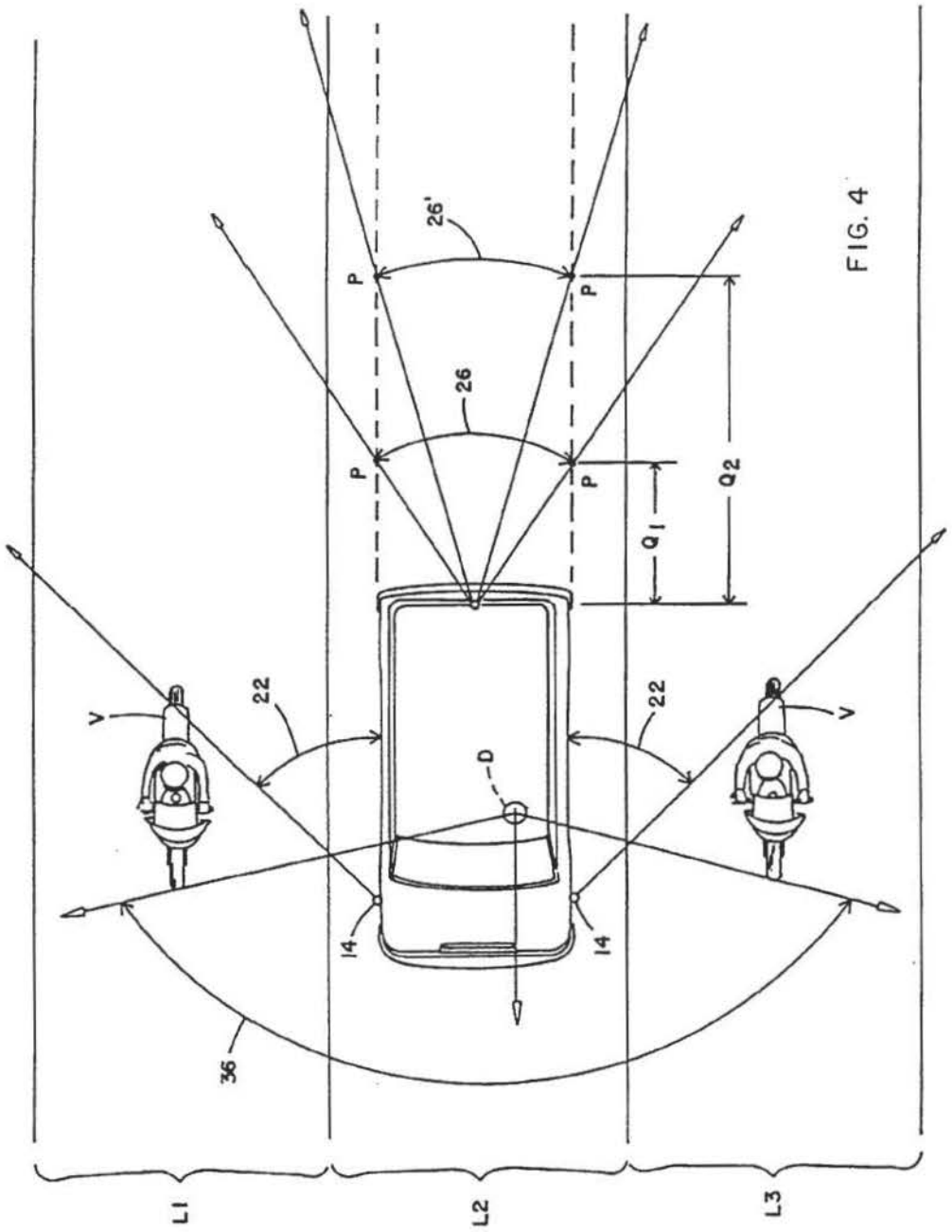


FIG. 4

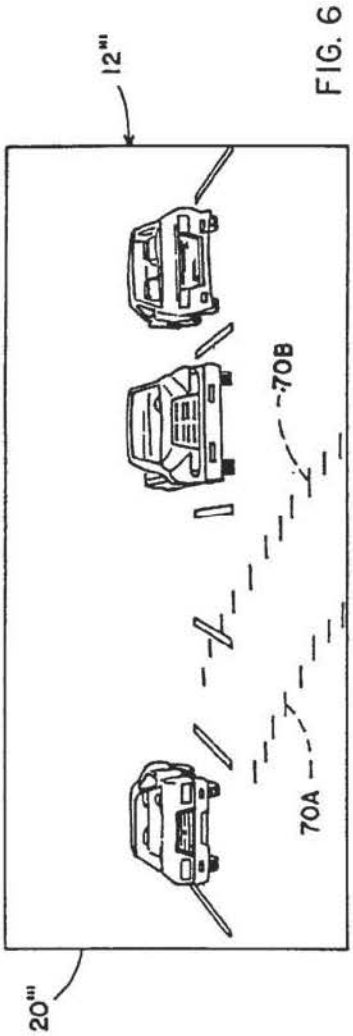

12'''
70B
70A
20'''

FIG. 6

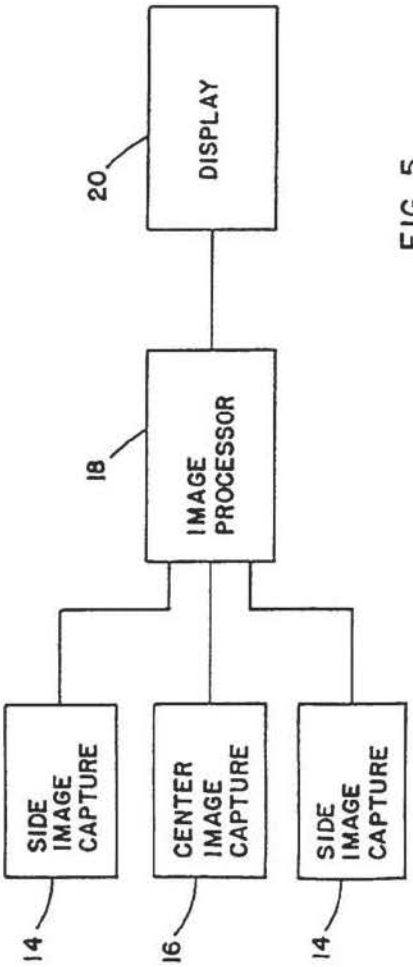

DISPLAY
20
IMAGE PROCESSOR
18
SIDE IMAGE CAPTURE
CENTER IMAGE CAPTURE
SIDE IMAGE CAPTURE
14
16
14

FIG. 5

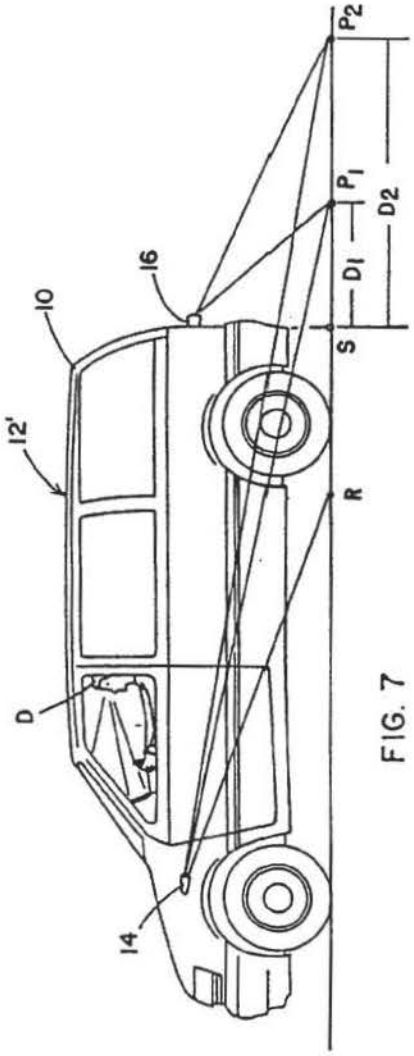


FIG. 7

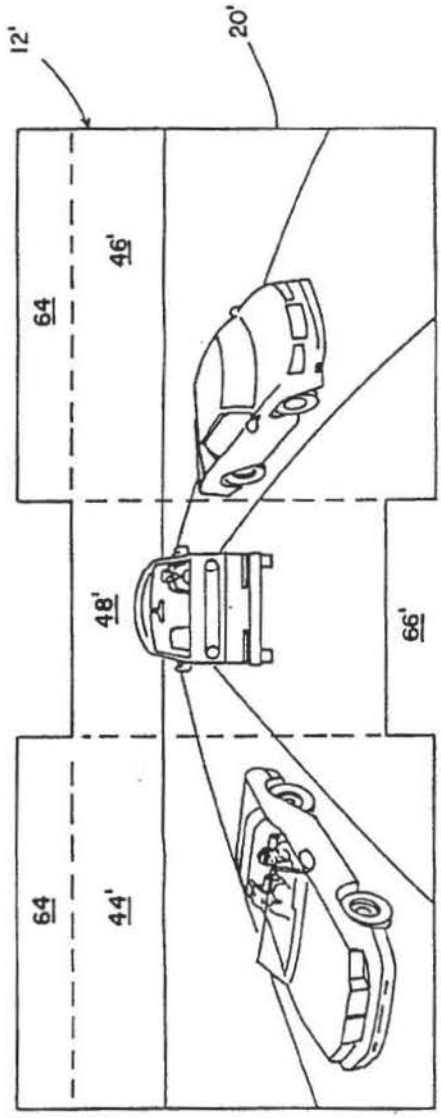


FIG. 8

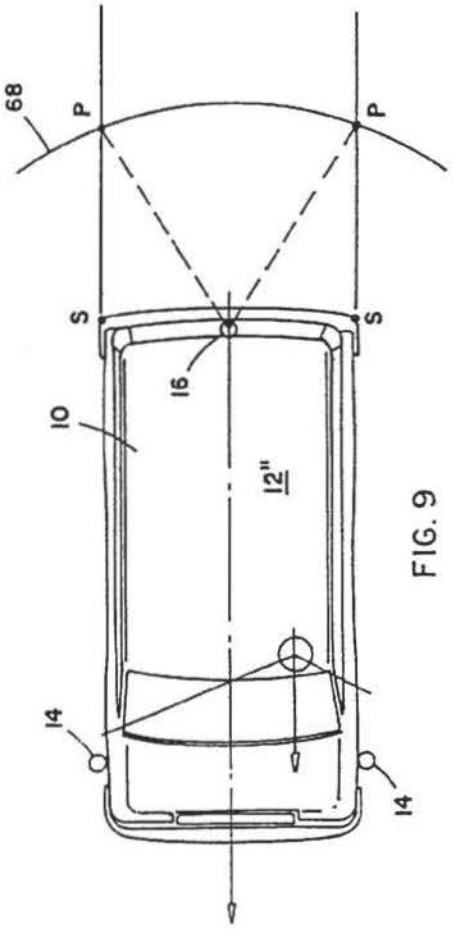

68
P
P
S
S
16
10
12"
14
14

FIG. 9

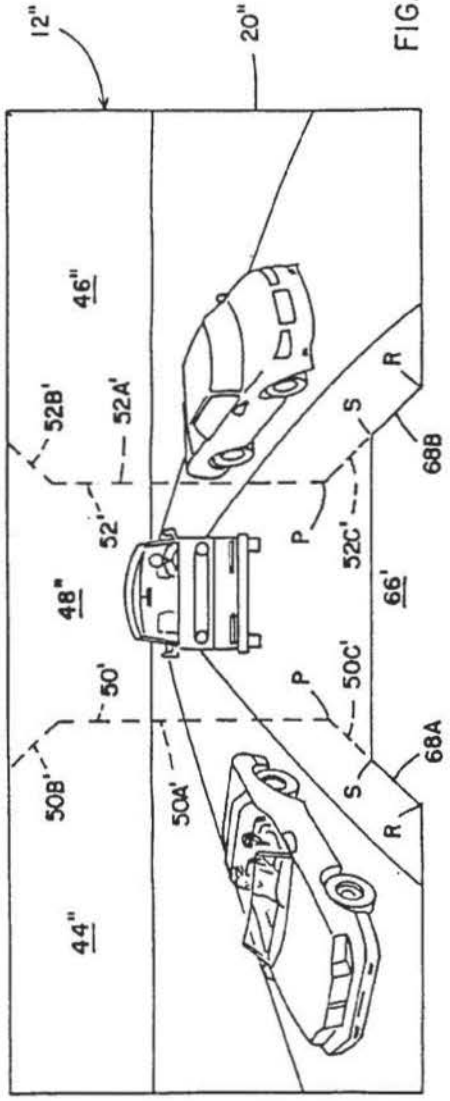

12"
20"
46"
52B'
52A'
52'
48"
50'
50B'
50A'
44"
R
S
68B
P
52C'
66'
50C'
P
S
68A
R

FIG. 10

92 N1	94 N2	92 N1	94 N2	92 N1	94 N2	90 92 N1	94 N2
1	1	45	54	94	146	143	
2	2	46	56	95	149	144	
3	3	47	57	96	151	145	
4	4	48	59	97	154	146	
5	5	49	60	98	156	147	
6	6	50	62	99	159	148	
7	7	51	63	100	162	149	
8	8	52	65	101	164	150	
9	9	53	66	102	167	151	
10	10	54	68	103	170	152	
11	11	55	70	104	172	153	
12	13	56	71	105	175	154	
13	14	57	73	106		155	
14	15	58	74	107		156	
15	16	59	76	108		157	
16	17	60	78	109		158	
17	18	61	79	110		159	
18	19	62	81	111		160	
19	20	63	83	112		161	
20	22	64	85	113		162	
21	23	65	86	114		163	
22	24	66	88	115		164	
23	25	67	90	116		165	
24	26	68	92	117		166	
25	28	69	94	118		167	
26	29	70	95	119		168	
27	30	71	97	120		169	
28	31	72	99	121		170	
29	33	73	101	122		171	
30	34	74	103	123		172	
31	35	75	105	124		173	
32	36	76	107	125		174	
33	38	77	109	126		175	
34	39	78	111	127			
35	40	79	113	128			
36	42	80	115	129			
37	43	81	117	130			
38	44	82	119	131			
39	46	83	121	132			
40	47	84	124	133			
41	49	85	126	134			
42	50	86	128	135			
43	51	87	130	136			
44	53	88	132	137			
		89	135	138			
		90	137	139			
		91	139	140			
		92	142	141			
		93	144	142			

FIG. 11

REARVIEW VISION SYSTEM WITH INDICIA OF BACKUP TRAVEL

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of application Ser. No. 08/935,336, filed on Sep. 22, 1997, which is a continuation of application Ser. No. 08/445,527, filed on May 22, 1995, now U.S. Pat. No. 5,670,935, which is a continuation-in-part of patent application Ser. No. 08/023,918 filed Feb. 26, 1993, by Kenneth Schofield and Mark Larson now U.S. Pat. No. 5,550,677.

BACKGROUND OF THE INVENTION

This invention relates generally to vision systems for vehicles and, more particularly, to rearview vision systems which provide the vehicle operator with scenic information in the direction rearward of the vehicle. More particularly, the invention relates to a rearview vision system utilizing image capture devices, such as CMOS imaging arrays and the like.

A long-felt need in the art of vehicle rearview vision systems has been to eliminate exterior rearview mirrors by utilizing image capture devices, such as cameras, in combination with dashboard displays. This would be beneficial because it would reduce wind drag on the vehicle, wind noise and vehicle weight. Furthermore, rearview mirrors protrude a substantial distance from the side of the vehicle, which makes maneuvering in tight spaces more difficult. Image capture devices are capable of positioning in a greater variety of locations on the vehicle, providing more flexibility of vehicle styling. It is further expected that camera systems would greatly reduce the blind spots to the sides and rear of the vehicle common with vehicles equipped with conventional rearview mirror systems. The driver cannot perceive vehicles, objects, or other road users in such blind spots without turning his or her body, which interferes with forward-looking visual activities.

Camera-based rearview vision systems for vehicles have not obtained commercial acceptance. One difficulty with proposed systems has been that they present a large amount of visual information in a manner which is difficult to comprehend. This difficulty arises from many factors. In order to significantly reduce blind spots, multiple image capture devices are typically positioned at various locations on the vehicle. The image of an object behind the equipped vehicle is usually captured by more than one image capture device at a time and displayed in multiple images. This may confuse the driver as to whether more than one object is present. When multiple image capture devices are positioned at different longitudinal locations on the vehicle, objects behind the vehicle are at different distances from the image capture devices. This results in different image sizes for the same object. This effect is especially noticeable for laterally extending images, such as a bridge, highway crosswalk markings, the earth's horizon, and the like. Such images are at different vertical angles with respect to the image capture devices. This results in different vertical positions on the display causing the elongated image to appear disjointed.

A camera system provides a monocular view of the scene, compared to the binocular, or stereoscopic, view obtained when the scene is viewed through a rearview mirror. This makes the ability to judge distances in a camera system a problem. This effect is most noticeable at distances close to the vehicle where stereoscopic imaging is relied upon extensively by the driver in judging relative locations of objects. Therefore, known camera systems fail to provide to the driver important information where that information is most needed—at small separation distances from surrounding objects.

Another difficulty with camera systems is that, in order to provide a sufficient amount of information, the camera system typically presents the driver with a greatly increased field of view. This improves performance by further reducing blind spots at the side and rear of the vehicle. However, an increased field of view is often obtained by utilizing a wide-angle lens which introduces distortion of the scene and further impairs the ability of the driver to judge distances of objects displayed. The problem with such distortion of the scene is that the driver must concentrate more on the display and take a longer time to interpret and extract the necessary information. This further distracts the driver from the primary visual task of maintaining awareness of vehicles and other objects in the vicinity of the driven vehicle.

SUMMARY OF THE INVENTION

The present invention is directed towards enhancing the interpretation of visual information in a rearview vision system by presenting information in a manner which does not require significant concentration of the driver or present distractions to the driver. This is accomplished according to the invention in a rearview vision system having at least two image capture devices positioned on the vehicle and directed rearwardly with respect to the direction of travel of the vehicle. A display is provided for images captured by the image capture devices. The display combines the captured images into an image that would be achieved by a single rearward-looking camera having a view unobstructed by the vehicle. In order to obtain all of the necessary information of activity, not only behind but also along side of the vehicle, the virtual camera should be positioned forward of the driver. The image synthesized from the multiple image capture devices may have a dead space which corresponds with the area occupied by the vehicle. This dead space is useable by the driver's sense of perspective in judging the location of vehicles behind and along side of the equipped vehicle.

The present invention provides techniques for synthesizing images captured by individual, spatially separated, image capture devices into such ideal image, displayed on the display device. This may be accomplished according to an aspect of the invention by providing at least three image capture devices. At least two of the image capture devices are side image capture devices mounted on opposite sides of the vehicle. At least one of the image capture devices is a center image capture device mounted laterally between the side image capture devices. A display system displays an image synthesized from outputs of the image capture devices. The displayed image includes an image portion from each of the image capture devices. The image portion from the center image capture device is vertically compressed.

It has been discovered that such vertical compression substantially eliminates distortion resulting from the spatial separation between the cameras and can be readily accomplished. In an illustrated embodiment, the image compression is carried out by removing selective ones of the scan lines making up the image portion. A greater number of lines are removed further away from the vertical center of the image.

The compression of the central image portion produces a dead space in the displayed image which may be made to

correspond with the area that would be occupied by the vehicle in the view from the single virtual camera. Preferably, perspective lines are included at lateral edges of the dead space which are aligned with the direction of travel of the vehicle and, therefore, appear in parallel with lane markings. This provides visual clues to the driver's sense of perspective in order to assist in judging distances of objects around the vehicle.

According to another aspect of the invention, image enhancement means are provided for enhancing the displayed image. Such means may be in the form of graphic overlays superimposed on the displayed image. Such graphic overlap may include indicia of the anticipated path of travel of the vehicle which is useful in assisting the driver in guiding the vehicle in reverse directions. Such graphic overlay may include a distance grid indicating distances behind the vehicle of objects juxtaposed with the grid.

These and other objects, advantages, and features of this invention will become apparent by review of the following specification in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top plan view of a vehicle having a rearview vision system according to the invention;

FIG. **2** is a side elevation of the vehicle in FIG. **1**;

FIG. **3** is a front elevation of a display according to the invention;

FIG. **4** is the same view as FIG. **1** illustrating an alternative embodiment of the invention;

FIG. **5** is a block diagram of an electronic system according to the invention;

FIG. **6** is the same view as FIG. **3** illustrating an alternate mode of operation of the system;

FIG. **7** is the same view as FIG. **2** illustrating an alternative embodiment of the invention;

FIG. **8** is the same view as FIG. **3** illustrating an alternative embodiment of the invention;

FIG. **9** is the same view as FIGS. **1** and **4** illustrating an alternative embodiment of the invention;

FIG. **10** is the same view as FIGS. **3** and **8** illustrating an alternative embodiment of the invention; and

FIG. **11** is a chart illustrating the horizontal row of pixels (n**1**, n**2**) on which an object will be imaged from two longitudinally separated image capture devices as that object is spaced at different longitudinal distances from the image capture devices.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now specifically to the drawings, and the illustrative embodiments depicted therein, a vehicle **10**, which may be an automobile, a light truck, a sport utility vehicle, a van, a bus, a large truck, or the like includes a rearview vision system, generally illustrated at **12**, for providing a driver of the vehicle with a view rearwardly of the vehicle with respect to the direction of travel D of the vehicle (FIG. **1**). Vision system **12** includes at least two side image capture devices **14** positioned, respectively, on opposite sides of vehicle **10** and a center image capture device **16** positioned on the lateral centerline of the vehicle. All of the image capture devices are directed generally rearwardly of the vehicle. Rearview vision system **12** additionally includes an image processor **18** for receiving data signals from image capture devices **14**, **16** and synthesizing, from the data signals, a composite image **42** which is displayed on a display **20**.

As will be set forth in more detail below, the images captured by image capture devices **14**, **16** are juxtaposed on display **20** by image processor **18** in a manner which approximates the view from a single virtual image capture device positioned forwardly of the vehicle at a location C and facing rearwardly of the vehicle, with the vehicle being transparent to the view of the virtual image capture device. Vision system **12** provides a substantially seamless panoramic view rearwardly of the vehicle without duplicate or redundant images of objects. Furthermore, elongated, laterally-extending, objects, such as the earth's horizon, appear uniform and straight across the entire displayed image. The displayed image provides a sense of perspective, which enhances the ability of the driver to judge location and speed of adjacent trailing vehicles.

Each of side image capture devices **14** has a field of view **22** and is aimed rearwardly with respect to the vehicle about an axis **24** which is at an angle, with respect to the vehicle, that is half of the horizontal field of view of the image capture device. In this manner, each of the image capture devices **14** covers an area bounded by the side of the vehicle and extending outwardly at an angle defined by the horizontal field of view of the respective side image capture device. Center image capture device **16** has a horizontal field of view **26**, which is symmetrical about the longitudinal axis of the vehicle. The field of view of each side image capture device **14** intersect the field of view of center image capture device **16** at a point P which is located a distance Q behind vehicle **10**.

Rear blind zones **30** are located symmetrically behind vehicle **10** extending from the rear of the vehicle to point P. Side blind zones **25** located laterally on respective sides of the vehicle extend rearwardly of the forward field of view **36** of the driver to the field of view **22** of the respective side image capture device **14**. An object will not be captured by side image capture devices **14** or center image capture devices **16** if the object is entirely within one of the blind zones **25**, **30**. In order for an object, such as another vehicle V or other road user travelling to the side of vehicle **10**, to be observed by an operator of vehicle **10**, the object must be either at least partially within the forward field of view **36** of the driver or be captured by image capture devices **14**, **16** and displayed on display **20**. FIG. **4** illustrates vehicle **10** travelling on a three-lane highway having lanes L1, L2, and L3 with the vehicle in lane L2. Another vehicle V is shown positioned mostly within one of the blind zones **25**, but with the rearmost portion of the vehicle V extending into field of view **22** where the vehicle image will be captured by one of side image capture devices **14**. In the illustrated embodiment, vehicle V is a motorcycle travelling in the center of lanes L1 or L3 and represents a worst case for observing a vehicle travelling at least partially within one of the blind zones **25**. In order for a portion of vehicle V to be extending either forwardly or rearwardly of the respective blind zone **25**, where the vehicle V may be observed by either the forward field of view **36** of the driver or by the rearview vision system **12**, the field of view **22** of side image capture devices **14** must be sufficiently wide to capture a portion of vehicle V as illustrated in FIG. **4**. Preferably, the horizontal field of view **22** of side image capture devices **14** is no greater than that required to provide sufficient coverage which would be in the range of between approximately 55 degrees and approximately 70 degrees. In the illustrated embodiment, the horizontal field of view **22** is 61 degrees. In order for a portion of vehicle V to be within a vertical field of view **40** of one of side image capture devices **14**, the field of view should extend to the pavement at a plane M which

intersects vehicle V (FIG. 2). Preferably, vertical field of view **40** is between approximately 60 degrees and approximately 75 degrees. In the illustrated embodiment, vertical field of view **40** is 66 degrees.

A left overlap zone **32** and a right overlap zone **34** extend rearward from respective points P where the horizontal fields of view of the side image capture devices intersect the field of view of center image capture device **16**. Overlap zones **32, 34** define areas within which an object will be captured both by center image capture device **16** and one of the side image capture devices **14**. An object in an overlap zone **32, 34** will appear on display **20** in multiple image portions in a redundant or duplicative fashion. In order to avoid the presentation of redundant information to the driver, and thereby avoid confusion and simplify the task of extracting information from the multiple images or combined images on display **20**, the object should avoid overlapping zones **32, 34**. In practice, this may be accomplished to a satisfactory extent by moving points P away from the vehicle and thereby increasing distance Q. It is desirable to increase distance Q to a length that will exclude vehicles travelling at a typical separation distance behind vehicle **10** from overlapping zones **32, 34**. This separation distance is usually a function of the speed at which the vehicles on the highway are travelling. The faster the vehicles are travelling, the further Q should be moved behind vehicle **10** to keep overlap zones **32** and **34** outside of the recommended vehicle spacing. If, however, the vehicles are travelling at a slower speed, then the generally accepted recommendation for vehicle spacing decreases and it is more likely that a vehicle will be within overlap zone **32, 34**. Therefore, the distance Q may be selected to accommodate expected vehicle spacing for an average driving speed of vehicle **10**.

Distance Q is a function of the effective horizontal field of view **26** of center image capture device **16**. As field of view **26** decreases, points P move further rearward of the vehicle from a distance Q_1, to a distance Q_2, as best illustrated in FIG. **4**. In order to increase distance Q to eliminate redundant and duplicative information displayed on display **20** for most driving conditions of vehicle **10**, field of view **26** is preferably less than 12 degrees. In the illustrated embodiment, field of view **26** is between 6 and 8 degrees. Alternatively, distance Q may be dynamically adjusted according to some parameter, such as the speed of vehicle **10**. This would allow Q to be greater when the vehicle is travelling at a faster speed, where vehicle separation tends to be larger, and vice versa. Field of view **26** may be adjusted by utilizing a selective presentation of pixels of the captured image in the displayed image.

Referring to FIG. **3**, image display device **20** displays a composite image **42** made up of a left image portion **44**, a right image portion **46**, and a center image portion **48**. Each image portion **44–48** is reversed from the image as captured by the respective image capture device **14, 16** utilizing conventional techniques. These techniques include reading the image in reverse with the image capture device, writing the image in reverse to display device **20**, or reversing the image in image processor **18**. Left image portion **44** is joined with central image portion **48** at a boundary **50**. Central image portion **48** is joined with right image portion **46** at a boundary **52**. As may best be seen in FIG. **3**, the image portions at boundaries **50** and **52** are continuous whereby composite image **42** is a seamless panoramic view rearwardly of the vehicle. As also is apparent from FIG. **3**, central image portion **48** is narrower than either left image portion **44** or right image portion **46**. This is a result of reducing the horizontal field of view **26** of center image capture device **16** sufficiently to move points P, and thus overlap zones **32** and **34**, a sufficient distance behind vehicle **10** to reduce redundant and duplicative images between image portions **44–48**. Composite image **42** provides a clear image, which avoids confusion and simplifies the task of extracting information from the multiple image portions **44–48**. As also may be seen by reference to FIG. **3**, display **20** may additionally include indicia such as the readout of a compass **54**, vehicle speed **56**, turn signals **58**, and the like as well as other graphical or video displays, such as a navigation display, a map display, and a forward-facing vision system. In this manner, rearview vision system **12** may be a compass vision system or an information vision system.

In the embodiment of rearview vision system **12** having a dynamically adjusted value of distance Q, the spacing between boundaries **50** and **52** will dynamically adjust in sequence with the adjustment of distance Q. Thus, as overlap zones **32, 34** move further away from the vehicle; for example, in response to an increase in speed of the vehicle, boundary lines **50** and **52** will move closer together and vice versa. In this manner, composite image **42** is dynamic, having image portions of dynamically adaptive sizes.

Display **20** is of a size to be as natural as possible to the driver. This is a function of the size of the display and the distance between the display and the driver. Preferably, the displayed image simulates an image reflected by a rearview mirror. As such, the size of display **20** is approximately the combined areas of the three rearview mirrors (one interior mirror and two exterior mirrors) conventionally used with vehicles. As best seen by reference to FIG. **2**, display **20** is preferably positioned within the driver's physiological field of view without obstructing the view through the windshield. It is known that the driver's field of view, with the head and eyes fixed forward, extends further in a downward direction than in an upward direction. Display **20** could be located above the vertical view through the windshield wherein the display may be observed at the upward portion of the driver's field of view. However, the position for the display illustrated in FIG. **2** is preferred wherein the display is within the lower portion of the driver's field of view.

Display **20**, in the illustrated embodiment, is a flat panel display, such as a back-lit liquid crystal display, a plasma display, a field emission display, or a cathode ray tube. However, the synthesized image could be displayed using other display techniques such as to provide a projected or virtual image. One such virtual display is a heads-up display. The display may be mounted/attached to the dashboard, facia or header, or to the windshield at a position conventionally occupied by an interior rearview mirror.

Although various camera devices may be utilized for image capture devices **14, 16**, an electro-optic, pixelated imaging array, located in the focal plane of an optical system, is preferred. Such imaging array allows the number of pixels to be selected to meet the requirements of rearview vision system **12**. The pixel requirements are related to the imaging aspect ratio of the respective image capture devices, which, in turn, are a function of the ratio of the vertical-to-horizontal field of view of the devices, as is well known in the art. In the illustrated embodiment, the imaging aspect ratio of side image capture devices **14** is 2:1 and the image aspect ratio of central image capture device **16** is variable down to 0.1:1. Such aspect ratio will produce images which will not typically match that of commercially available displays. A commercially available display may be used, however, by leaving a horizontal band of the display for displaying alpha-numeric data, such as portions of an instrument cluster, compass display, or the like, as illustrated in FIG. **3**.

In the illustrated embodiment, image capture devices **14**, **16** are CMOS imaging arrays of the type manufactured by VLSI Vision Ltd. of Edinburgh, Scotland, which are described in more detail in co-pending U.S. patent application Ser. No. 08/023,918 filed Feb. 26, 1993, by Kenneth Schofield and Mark Larson for an AUTOMATIC REAR-VIEW MIRROR SYSTEM USING A PHOTOSENSOR ARRAY, the disclosure of which is hereby incorporated herein by reference. However, other pixelated focal plane image-array devices, which are sensitive to visible or invisible electromagnetic radiation, could be used. The devices could be sensitive to either color or monochromatic visible radiation or near or far infrared radiation of the type used in night-vision systems. Each image capture device could be a combination of different types of devices, such as one sensitive to visible radiation combined with one sensitive to infrared radiation. Examples of other devices known in the art include charge couple devices and the like.

Preferably, image capture devices **14** and **16** are all mounted at the same vertical height on vehicle **10**, although compromise may be required in order to accommodate styling features of the vehicle. The horizontal aim of image capture devices **14** and **16** is preferably horizontal. However, the portion of the image displayed is preferably biased toward the downward portion of the captured image because significantly less useful information is obtained above the horizontal position of the image capture devices.

Each image-capturing device **14**, **16** is controlled by appropriate supporting electronics (not shown) located in the vicinity of the imaging array such that, when operating power is supplied, either an analog or a digital data stream is generated on an output signal line supplied to image processor **18**. The support electronics may be provided partially on the image chip and partially on associated electronic devices. For each exposure period, a value indicative of the quantity of light incident on each pixel of the imaging array during the exposure period is sequentially outputted in a predetermined sequence, typically row-by-row. The sequence may conform to video signal standards which support a direct view such that, when a scene is viewed by an image-capturing device, the image presented on a display represents directly the scene viewed by the image-capturing devices. However, when looking forward and observing a displayed image of a rearward scene, the driver will interpret the image as if it were a reflection of the scene as viewed through a mirror. Objects to the left and rearward of the vehicle, as viewed by the rearward-looking camera, are presented on the left-hand side of the display and vice versa. If this reversal is effected in image processor **18**, it may be by the use of a data storage device, or buffer, capable of storing all of the pixel values from one exposure period. The data is read out of the data storage device in a reversed row sequence. Alternatively, the imaging array electronics could be constructed to provide the above-described reversal at the image-capturing device or at the display.

Data transmission between image capture devices **14**, **16** and image processor **18** and/or between image processor **18** and display **20** may be by electrically conductive leads or fiber-optic cable. It is possible, for particular applications, to eliminate image processor **18** and direct drive display **20** from image capture devices **14**, **16** at the pixel level.

The data streams from image-capturing devices **14**, **16** are combined in image processor **18** and directly mapped to the pixel array of display **20**. This process is repeated preferably at a rate of at least 30 times per second in order to present an essentially real time video image. The image captured by side image capture device **14** on the right side of the vehicle is presented in right image portion **46** and the image from side image capture device **14** on the left side of the vehicle is displayed on left image portion **44**. The image from center image capture device **16** is displayed on central image portion **48**. The three image portions **44**–**48** are presented in horizontal alignment and adjacent to each other. However, the composite image may be positioned at any desired vertical position in the display **20**. It is also possible to display image portions **44**–**48** on separate image devices which are adjacent each other.

In vision system **12**, side image capture devices **14** are positioned preferably at a forward longitudinal position on vehicle **10** and center image capture device **16** is positioned at a rearward longitudinal position on the vehicle. As best seen by reference to FIG. **7**, this positioning creates a difference in the vertical angle between each side image capture device **14** and center image capture device **16** with respect to a fixed location P_1 that is a distance D_1 behind the vehicle. This difference in sensing angle will cause each side image capture device **14** to image an object located at P_1 on a horizontal row of pixels that is different from the horizontal row of pixels that center image capture device **16** will image the same object. If the image is below the horizontal centerline of the image capture device, it will be imaged on a lower row of pixels by center image capture device **16** than the row of pixels it will be imaged by the side image capture devices **14**, as illustrated in FIG. **7**. This mismatch between horizontal pixel rows of the captured image is furthermore a function of the distance of the captured image from the rear of the vehicle. This can be understood by reference to FIG. **11** which presents a chart **90** having a first column **92** of pixel lines **n1**, measured from the array centerline, at which an object will be imaged by side image capture device **14** and a second column **94** of pixel lines **n2**, measured from the array vertical centerline, at which the same object will be imaged by center image capture device **16**. The result is that an object, which is captured by both side and center image capture devices **14**, **16**, will be vertically disjointed at the boundary of the displayed image, if the object is captured by more than one image capture device. The amount of disjointment will be greater closer to the vehicle and less at further distances. If the object is elongated in the horizontal direction, such as earth's horizon, bridges, or cross-markings on highways, then the object will appear to be either broken or crooked.

In order to provide uniform display of laterally elongated images, a rearview vision system **12'** is provided having a central image portion **48'** which is processed differently from the image display portions **44'** and **46'** produced by the side image capture devices (FIG. **8**). Central image portion **48'** is reduced vertically, or compressed, by removing specified scan lines, or pixel rows, from the image captured by center image capture device **16** in a graduated fashion. The difference in the pixel line at which an object will be imaged by each of the side and center image capture devices is a function of the distance D of the object from the rear of the vehicle, with a greater variation occurring at shorter distances and the variation reducing to zero for infinite distances. Therefore, the compression of central image portion **48'** is non-linear, with substantially no compression at the vertical center of the image and greater compression at greater distances above and below the vertical center point of the image. This is accomplished by removing specific lines from the center display in a graduated fashion with a greater number of lines removed further from the vertical center of the image. The removed lines may be merely

discarded in order to vertically reduce the image. Alternatively, the data contained in the removed lines may be utilized to modify the value of adjacent pixels above and below the removed line in order to enhance the quality of the compressed image. Averaging, median filtering, or other such known techniques may also be used.

Each of right image portion **46'** and left image portion **44'** includes an upper portion **64** which extends above the compressed upper portion of the central image portion **48'**. In the illustrated embodiment, upper portions **64** are deleted in order to present a uniform upper horizontal boundary for display **20'**. In the illustrated embodiment, the mismatch between the lower horizontal boundary of central image portion **48'** and each of the left and right image portions provides a dead space **66** which provides a visual prompt to the user of the approximate location of the rearward corners S of vehicle **10**. This dead space **66** in the image displayed on display **20'** approximates the footprint occupied by vehicle **10** when viewed from point C. This is particularly useful because it provides a visual indication to the driver that a vehicle passing vehicle **10**, as viewed in either left image portion **44'** or right image portion **46'**, is at least partially adjacent vehicle **10** if the image of the approaching vehicle is partially adjacent to dead space **66**.

In an alternative embodiment, the vertical compression technique may be applied to only a lower vertical portion of central image portion **48'**. In most driving situations, objects imaged by rearward-facing image capture devices above the horizon are at a long distance from the vehicle while those below the horizon get progressively closer to the vehicle in relation to the distance below the horizon in the displayed image. Therefore, compression of the upper vertical portion of the central image portion may be eliminated without significant reduction in performance.

Compression of the central image portion may also advantageously be provided horizontally, as well as vertically. Spatial separation of center image capture device **16** from side image capture devices **14** causes similar distortion, as that described above, in the horizontal direction. This effect is spherical in nature and would require a more complex corrective action, such as compressing the image based upon the removal of pixels from an approximation to concentric circles centered on the center of the imaging array, or other techniques which would be apparent to those skilled in the art.

A rearview vision system **12"** includes an image display **20"** having a compressed central image portion **48"** and left and right image portions **44"** and **46"**, respectively (FIG. **10**). A border **50'** between left side image **44"** and central image **48"** includes a vertical central border portion **50***a'*, an upper border portion **50***b'*, and a lower border portion **50***c'*. Upper border portion **50***b'* and lower border portion **50***c'* diverge laterally outwardly, vertically away from central portion **50***a'*. A border **52'** between central image portion **48"** and right image portion **46"** includes a central boundary portion **52***a'*, an upper boundary portion **52***b'*, and a lower boundary portion **52***c'*. Upper boundary portion **52***b'*and lower boundary portion **52***c'*diverge laterally outwardly vertically away from central portion **52***a'*. This creates an upper portion of central image portion **48"** and a lower portion of central image portion **48"** which extend beyond the center portion thereof. This configuration is based upon the realization that the surface of the road immediately behind the vehicle is captured by central image capture device **16**. Likewise, the horizontal plane above the vehicle, which is symmetrical with the road surface, is captured by the center image capture device. This may be seen by referring to point P in FIG. **10**, which illustrate the points where the effective radius **68** of the virtual image capture device intersects dead zones **30** and by referring to point S in FIG. **10** which illustrates the corners or the rear of the vehicle (S).

The image displayed on display **20"** includes a dead space **66'** having diverging lateral sides **68***a*, **68***b*. Diverging sides **68***a* and **68***b* are configured in order to extend in the direction of travel of vehicle **10** which is parallel to lane markings of a highway on which vehicle **10** is travelling. This further enhances the visual perception of the driver by providing a visual clue of the location of images appearing on display **20"** with respect to the vehicle **10**. Side portions **68***a*, **68***b*, in the illustrated embodiment, are natural extensions of lower boundary portions **50***c'* and **52***c'* and extend from point S on each respective side of the vehicle to point R, which represents the intersection of the lower extent of the vertical field of view **40** of each side image capture device **14** with the pavement (FIG. **7**).

Rearview vision systems **12'** and **12"** utilize a displayed synthesized image which takes into account the use of perspective in enhancing the driver's understanding of what is occurring in the area surrounding the vehicle. The images produced on displays **20'** and **20"** effectively remove the vehicle bodywork and replace the bodywork with a vehicle footprint as would be viewed by virtual camera C. The image displayed on display **20"** further includes perspective lines which further enhance the roll of perspective in the driver's understanding of what is occurring.

In order to further enhance the driver's understanding of what is occurring in the area surrounding the vehicle, a rearview vision system **12'"** includes a display **20'"** having image enhancements (FIG. **6**). In the illustrative embodiment, such image enhancements include graphic overlays **70***a*, **70***b* which are hash marks intended to illustrate to the driver the anticipated path of movement of vehicle **10**. In the illustrated embodiment, the anticipated vehicle motion is a function of the vehicle direction of travel as well as the rate of turn of the vehicle. The forward or rearward direction of vehicle travel is determined in response to the operator placing the gear selection device (not shown) in the reverse gear position. The degree of turn of the vehicle may be determined by monitoring the movement of the vehicle steering system, monitoring the output of an electronic compass, or monitoring the vehicle differential drive system. In the embodiment illustrated in FIG. **6**, the configuration of graphic overlays **70***a*, **70***b* indicates that the vehicle is in reverse gear and that the wheels are turned in a manner that will cause the vehicle to travel toward the driver's side of the vehicle. If the wheels were turned in the opposite direction, graphic overlays **70***a*, **70***b* would curve clockwise toward the right as viewed in FIG. **6**. If the vehicle's wheels were straight, graphic overlays **70***a*, **70***b* would be substantially straight converging lines. If the vehicle is not in reverse gear position, graphic overlays **70***a*, **70***b* are not presented. Other types of graphic overlays of the displayed image are comprehended by the invention.

Horizontal grid markings on the display may be provided to indicate distances behind the vehicle at particular markings. Such grid would allow the driver to judge the relative position of vehicles behind the equipped vehicle. In one embodiment, short horizontal lines are superimposed on the displayed image at regular rearward intervals in horizontal positions which correspond to the boundaries of the lane in which the vehicle is travelling. In order to avoid confusion when the vehicle is travelling in a curved path, from a lack of correspondence between the graphic overlay and the road, a signal indicative of the vehicle's rate of turn may be taken

into account when generating the graphic overlay. In this manner, the distance indications may be moved laterally, with reduced horizontal separation, to correspond to the positions of the curved lane boundaries and vertically on the image to compensate for the difference between distances along a straight and curved path.

Another image enhancement is to alter the appearance of an object in a particular zone surrounding the vehicle in order to provide an indication, such as a warning, to the driver. As an example, a vehicle that is too close to the equipped vehicle for safe-lane change, may be displayed in a particular color, such as red, may flash, or otherwise be distinguishable from other images on the display. Preferably, the speed of the equipped vehicle **10**, which may be obtained from known speed transducers, may be provided as an input to the rearview vision system in order to cause such warning to be a function of the vehicle speed which, in turn, affects the safe separation distance of vehicles. The operation of the turn signal may also be used to activate such highlighting of other road users or to modify the scope of the image displayed. In order to determine the distance of objects behind vehicle **10**, a separate distance-measuring system may be used. Such separate system may include radar, ultrasonic sensing, infrared detection, and other known distance-measuring systems. Alternatively, stereoscopic distance-sensing capabilities of side image capture devices **14** may be utilized to determine the separation distance from trailing objects utilizing known techniques.

Thus, it is seen that the image displayed on display **20**–**20'''** may be different under different circumstances. Such different circumstances may relate to the vehicle's direction of travel, speed, rate of turn, separation from adjacent objects, and the like.

Various other forms of image processing may be utilized with rearview vision system **12**–**12'''**. Luminant and chrominant blending may be applied to the images captured by image capture devices **14**, **16** in order to produce equality of the image data whereby the image portions appear as if they were produced by one image capture device. The dynamic range of the image capture devices may be extended in order to provide high quality images under all lighting conditions. Furthermore, individual pixel groups may be controlled in order to selectively compensate for bright or dark spots. For example, anti-blooming techniques may be applied for bright spots. Multiple exposure techniques may be applied to highlight dark areas. Image morphing and warping compensation techniques may additionally be applied. Resolution of the image capture devices and display may be selected in order to provide sufficient image quality for the particular application.

A heater may be applied to each image capture device in order to remove dew and frost that may collect on the optics of the device. Although, in the illustrative embodiment, the optical centerline of the camera coincides with the field of view, particular applications may result in the centerline of the camera pointing in a direction other than the centerline of the field of view. Although, in the illustrative embodiment, the image capture devices are fixed, it may be desirable to provide selective adjustability to the image capture devices or optical paths in particular applications. This is particularly desirable when the system is used on articulated vehicles where automated and coordinated camera aim may be utilized to maintain completeness of the synthesized image.

When operating the vehicle in the reverse direction, it may be desirable to provide additional data concerning the area surrounding the immediate rear of the vehicle. This may be accomplished by utilizing non-symmetrical optics for the center image capture device in order to provide a wide angle view at a lower portion of the field of view. Alternatively, a wide angle optical system could be utilized with the electronic system selectively correcting distortion of the captured image. Such system would provide a distortion-free image while obtaining more data, particularly in the area surrounding the back of the vehicle.

The invention additionally comprehends the use of more than three image capture devices. In addition to side image capture devices positioned at the front sides of the vehicle and a center image capture device positioned at the center rear of the vehicle, additional image capture devices may be useful at the rear corners of the vehicle in order to further eliminate blind spots. It may additionally be desirable to provide an additional center image capture device at a higher elevation in order to obtain data immediately behind the vehicle and thereby fill in the road surface detail immediately behind the vehicle. Such additional detail is particularly useful when operating the vehicle in the reverse direction. Of course, each of the image capture devices could be a combination of two or more image capture devices.

Although the present invention is illustrated as used in a rearview vision system, it may find utility in other applications. For example, the invention may be useful for providing security surveillance in an area where a building or other object obstructs the view of the area under surveillance. Additionally, the invention may find application in night-vision systems and the like. For example, the invention may be applied to forward-facing night-vision systems, or other vision enhancement systems such as may be used in adverse weather or atmospheric conditions such as fog, applied to provide an enhanced display of a synthesized image, which approximates a forward-facing view from a single virtual camera located rearwardly of the driver, taking advantage of the perspective features of the image.

Thus, it is seen that the present invention enhances the relationship between the driver's primary view and the image presented on the rearview vision system. This is accomplished in a manner which provides ease of interpretation while avoiding confusion so that the driver does not have to concentrate or look closely at the image. In this manner, information presented on the display is naturally assimilated. This is accomplished while reducing blind spots so that other vehicles or objects of interest to the driver will likely be displayed to the driver. Additionally, the use of perspective allows distances to be more accurately determined.

Changes and modifications in the specifically described embodiments can be carried out without departing from the principles of the invention, which is intended to be limited only by the scope of the appended claims, as interpreted according to the principles of patent law including the doctrine of equivalents.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A rearview vision system for a vehicle having a gear actuator, comprising:

an image capture device mounted at the rear of the vehicle and having a field of view directed rearwardly of the vehicle;

a display system viewable by a driver of the vehicle which displays a rearward image output of said image capture device;

a graphic overlayer superimposed on said rearward image when the gear actuator of the vehicle selects a reverse gear; and

wherein said graphic overlayer includes indicia of the anticipated path of travel of the vehicle.

2. The rearview system of claim 1 wherein said indicia responds to the direction of turn of the vehicle.

3. The rearview system of claim 1 wherein said indicia responds to at least one of the vehicle's steering system, the vehicle's differential system and a compass.

4. The rearview system of claim 1 wherein said graphic overlayer is not superimposed on said rearward image when the gear actuator of the vehicle does not select a reverse gear.

5. The rearview system of claim 1 wherein said indicia comprise markings that provide indication of distance behind the vehicle.

6. The rearview system of claim 1 wherein said indicia comprise markings superimposed at intervals on said rearward image corresponding to the boundaries of the lane in which the vehicle is reversing.

7. The rearview system of claim 6 wherein said graphic overlayer is responsive to a signal indicative of the rate of turn of the vehicle.

8. The rearview system of claim 1 wherein said graphic overlayer is responsive to a signal indicative of the rate of turn of the vehicle.

9. The rearview system of claim 1 wherein said graphic overlayer comprises markings that move laterally on said rearward image, with reduced separation, to correspond to positions of a curved lane boundary and vertically on said rearward image to compensate for the difference between distances along a straight and curved path.

10. The rearview system of claim 1 wherein said rearview vision system includes a distance-sensing system.

11. The rearview system of claim 10 wherein said distance-sensing system is selected from the group consisting of a radar, an ultrasonic sensing, and an infrared detection distance-measuring system.

12. The rearview system of claim 1 wherein said image capture device has a field of view which is symmetrical about the longitudinal axis of the vehicle.

13. The rearview system of claim 1 wherein said image capture device comprises a pixilated imaging array.

14. The rearview system of claim 13 wherein said pixilated array comprises a CMOS imaging array.

15. The rearview system of claim 1 wherein said graphic overlayer has a form that is a function of at least one of the direction of travel and speed of the vehicle.

16. The rearview system of claim 15 wherein said indicia comprises at least one mark superimposed on said rearward image.

17. The rearview system of claim 1 wherein said rear vision system includes a monitoring device for monitoring vehicle turning.

18. The rearview system of claim 17 wherein said monitoring device comprises one of a monitor of movement of the vehicle's steering system, a monitor of an output of an electronic compass and a monitor of the vehicle's differential drive system.

19. The rearview system of claim 1 wherein said display system comprises one of a flat panel display and a cathode ray tube.

20. The rearview system of claim 1 wherein said display system comprises a flat panel display.

21. The rearview system of claim 20 wherein said flat panel display comprises one of a liquid crystal display, a plasma display and a field emission display.

22. The rearview system of claim 20 wherein said flat panel display comprises a liquid crystal display.

23. The rearview system of claim 1 wherein said display system is positioned within the field of view of the driver without obstructing the view through the windshield.

24. The rearview system of claim 1 wherein said display system is mounted to one of the dashboard, facia, header and windshield of the vehicle.

25. The rearview system of claim 1 wherein said display system is mounted at a position conventionally occupied by an interior rearview mirror.

26. The rearview system of claim 1 wherein said display system comprises a display of one of a projected and a virtual image.

27. The rearview system of claim 1 wherein said display system comprises a heads-up display.

28. The rearview system of claim 1 wherein said indicia comprises at least one mark superimposed on said rearward image.

29. The rearview system of claim 28 wherein said at least one mark superimposed on said rearward image comprises a plurality of marks superimposed on said rearward image at rearward intervals.

30. The rearview system of claim 29 wherein said plurality of marks superimposed on said rearward image are positioned to correspond to boundaries of the lane in which the vehicle is traveling.

31. The rearview system of claim 29 wherein said plurality of marks are moved laterally to correspond to positions of curved lane boundaries when the vehicle is turning.

32. A rearview vision system for a vehicle having a gear actuator, comprising:

an image capture device mounted at the rear of the vehicle and having a field of view directed rearwardly of the vehicle;

a display system viewable by a driver of the vehicle which displays a rearward image output of said image capture device;

a graphic overlayer superimposed on said rearward image when the gear actuator of the vehicle selects a reverse gear; and

wherein said graphic overlayer is disabled when the gear actuator of the vehicle is not in reverse gear.

33. The rearview system of claim 32 wherein said graphic overlayer includes indicia of the anticipated path of travel of the vehicle.

34. The rearview system of claim 33 wherein said indicia responds to at least one of the vehicle's steering system, the vehicle's differential system and a compass.

35. The rearview system of claim 33 wherein said indicia responds to the direction of turn of the vehicle.

36. The rearview system of claim 33 wherein said indicia comprise markings that provide indication of distance behind the vehicle.

37. The rearview system of claim 33 wherein said indicia comprise markings superimposed at intervals on said rearward image corresponding to the boundaries of the lane in which the vehicle is reversing.

38. The rearview system of claim 37 wherein said graphic overlayer is responsive to a signal indicative of the rate of turn of the vehicle.

39. The rearview system of claim 32 wherein said graphic overlayer is responsive to a signal indicative of the rate of turn of the vehicle.

40. The rearview system of claim 32 wherein said indicia comprise markings that move laterally on said rearward image, with reduced separation, to correspond to positions

of a curved lane boundary and that move vertically on said rearward image to compensate for the difference between distances along a straight and curved path.

41. The rearview system of claim **32** wherein said rearview vision system includes a distance-sensing system.

42. The rearview system of claim **41** wherein said distance-sensing system is selected from the group consisting of a radar, an ultrasonic sensing, and an infrared detection distance-measuring system.

43. The rearview system of claim **32** wherein said image capture device has a field of view which is symmetrical about the longitudinal axis of the vehicle.

44. The rearview system of claim **32** wherein said image capture device comprises a pixilated imaging array.

45. The rearview system of claim **44** wherein said pixilated array comprises a CMOS imaging array.

46. The rearview system of claim **33** wherein said graphic overlayer has a form that is a function of at least one of the direction of travel and speed of the vehicle.

47. The rearview system of claim **46** wherein said indicia comprises at least one mark superimposed on said rearward image.

48. The rearview system of claim **32** wherein said rear vision system includes a monitoring device for monitoring vehicle turning.

49. The rearview system of claim **48** wherein said monitoring device comprises one of a monitor of movement of the vehicle's steering system, a monitor of an output of an electronic compass and a monitor of the vehicle's differential drive system.

50. The rearview system of claim **32** wherein said display system comprises one of a flat panel display and a cathode ray tube.

51. The rearview system of claim **32** wherein said display system comprises a flat panel display.

52. The rearview system of claim **51** wherein said flat panel display comprises one of a liquid crystal display, a plasma display and a field emission display.

53. The rearview system of claim **51** wherein said flat panel display comprises a liquid crystal display.

54. The rearview system of claim **32** wherein said display system is positioned within the field of view of the driver without obstructing the view through the windshield.

55. The rearview system of claim **32** wherein said display system is mounted to one of the dashboard, facia, header and windshield of the vehicle.

56. The rearview system of claim **32** wherein said display system is mounted at a position conventionally occupied by an interior rearview mirror.

57. The rearview system of claim **32** wherein said display system comprises a display of one of a projected and a virtual image.

58. The rearview system of claim **32** wherein said display system comprises a heads-up display.

59. The rearview system of claim **33** wherein said indicia comprises at least one mark superimposed on said rearward image.

60. The rearview system of claim **59** wherein said at least one mark superimposed on said rearward image comprises a plurality of marks superimposed on said rearward image at rearward intervals.

61. The rearview system of claim **60** wherein said plurality of marks superimposed on said rearward image are positioned to correspond to boundaries of the lane in which the vehicle is traveling.

62. The rearview system of claim **60** wherein said plurality of marks are moved laterally to correspond to positions of curved lane boundaries when the vehicle is turning.

63. A rearview vision system for a vehicle having a gear actuator, comprising:

an image capture device mounted at the rear of the vehicle and having a field of view directed rearwards of the vehicle;

a display system viewable by a driver of the vehicle;

said image capture device utilizing a wide angle optical system in order to provide a wide angle view of an area rearwards of the vehicle wherein said wide angle optical system comprises non-symmetrical optics; and

wherein said display system displays a rearward image output of said image capture device when the gear actuator of the vehicle selects a reverse gear to operate the vehicle in reverse and wherein said display of said rearward image output of said image capture device is disabled when the vehicle's gear actuator is not in reverse gear.

64. The rearview system of claim **63** wherein said wide angle view comprises a view at a lower portion of said rearwards directed field of view of said image capture device.

65. The rearview system of claim **64** wherein said wide angle view comprises an area at the back of the vehicle.

66. The rearview system of claim **65** wherein the output of said image capture device is corrected for distortion in the image captured by said wide angle optical system.

67. The rearview system of claim **66** wherein said correction of said distortion is achieved electronically.

68. The rearview system of claim **65** wherein said rearview vision system includes a distance-measuring system.

69. The rearview system of claim **68** wherein said distance-measuring system is selected from the group consisting of a radar, an ultrasonic sensing, and an infrared detection distance-measuring system.

70. The rearview system of claim **65** wherein said image capture device has a field of view which is symmetrical about the longitudinal axis of the vehicle.

71. The rearview system of claim **65** wherein said image capture device comprises a pixelated imaging array.

72. The rearview system of claim **71** wherein said pixelated array comprises a CMOS imaging array.

73. The rearview system of claim **65** wherein said display system comprises one of a flat panel display and a cathode ray tube.

74. The rearview system of claim **65** wherein said display system comprises a flat panel display.

75. The rearview system of claim **74** wherein said flat panel display comprises one of a liquid crystal display, a plasma display and a field emission display.

76. The rearview system of claim **75** wherein said flat panel display comprises a liquid crystal display.

77. The rearview system of claim **65** wherein said display system is positioned within the field of view of the driver without obstructing the view through the windshield.

78. The rearview system of claim **65** wherein said display system is mounted to one of the dashboard, facia, header and windshield of the vehicle.

79. The rearview system of claim **65** wherein said display system is mounted at a position conventionally occupied by an interior rearview mirror.

80. The rearview system of claim **65** wherein said display system comprises display of one of a projected and a virtual image.

81. The rearview system of claim **65** wherein said display system comprises a heads-up display.

82. A rearview vision system for a vehicle having a gear actuator, comprising:

an image capture device mounted at the rear of the vehicle and having a field of view directed rearwards of the vehicle;

a display system viewable by a driver of the vehicle;

said image capture device utilizing a wide angle optical system comprising non-symmetrical optics in order to provide a wide angle view of an area rearwards of the vehicle; and

wherein said display system displays a rearward image output of said image capture device when the gear actuator of the vehicle selects a reverse gear to operate the vehicle in reverse.

83. The rearview system of claim **82** wherein said wide angle view comprises a view at a lower portion of said rearwards directed field of view of said image capture device.

84. The rearview system of claim **83** wherein said wide angle view comprises an area at the back of the vehicle.

85. The rearview system of claim **82** wherein said display of said rearward image output of said image capture device is disabled when the vehicle's gear actuator is not in reverse gear.

86. The rearview system of claim **82** wherein the output of said image capture device is corrected for distortion in the image captured by said wide angle optical system.

87. The rearview system of claim **86** wherein said correction of said distortion is achieved electronically.

88. The rearview system of claim **82** wherein said rearview vision system includes a distance-measuring system.

89. The rearview system of claim **88** wherein said distance-measuring system is selected from the group consisting of a radar, an ultrasonic sensing, and an infrared detection distance-measuring system.

90. The rearview system of claim **82** wherein said image capture device has a field of view which is symmetrical about the longitudinal axis of the vehicle.

91. The rearview system of claim **82** wherein said image capture device comprises a pixelated imaging array.

92. The rearview system of claim **91** wherein said pixelated array comprises a CMOS imaging array.

93. The rearview system of claim **82** wherein said display system comprises one of a flat panel display and a cathode ray tube.

94. The rearview system of claim **82** wherein said display system comprises a flat panel display.

95. The rearview system of claim **94** wherein said flat panel display comprises one of a liquid crystal display, a plasma display and a field emission display.

96. The rearview system of claim **95** wherein said flat panel display comprises a liquid crystal display.

97. The rearview system of claim **82** wherein said display system is positioned within the field of view of the driver without obstructing the view through the windshield.

98. The rearview system of claim **82** wherein said display system is mounted to one of the dashboard, facia, header and windshield of the vehicle.

99. The rearview system of claim **82** wherein said display system is mounted at a position conventionally occupied by an interior rearview mirror.

100. The rearview system of claim **82** wherein said display system comprises display of one of a projected and a virtual image.

101. The rearview system of claim **82** wherein said display system comprises a heads-up display.

* * * * *

United States Court of Appeals
for the Federal Circuit
In re: Magna Electronics, Inc., 2014-1798

XIII. PROOF OF SERVICE

I, Robyn Cocho, being duly sworn according to law and being over the age of 18, upon my oath depose and say that:

Counsel Press was retained by GARDNER, LINN, BURKHART & FLORY, LLP, Attorneys for Appellant to print this document. I am an employee of Counsel Press.

On **November 7, 2014** counsel has authorized me to electronically file the foregoing **Brief of Appellant** with the Clerk of Court using the CM/ECF System, which will serve via e-mail notice of such filing to all counsel registered as CM/ECF users, including any of the following:

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Counsel Press

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1. This brief complies with the type-volume limitation of Federal Rule of Appellate Procedure 32(a)(7)(B).

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/s/Terence J. Linn
Terence J. Linn
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Counsel for Appellant